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CALIFORNIA DRAINAGE BASINS. A COOPERATIVE STATE-FEDERAL REPORT ON WATER POLLUTION

Public Health Service
San Francisco, California

1951

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For Clean Water—"One River, One Plan"

California
DRAINAGE BASINS

A COOPERATIVE STATE-FEDERAL REPORT ON WATER POLLUTION

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FEDERAL SECURITY AGENCY

Public Health Service

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SUMMARY REPORT ON WATER POLLUTION

California Drainage Basins

Prepared by

FEDERAL SECURITY AGENCY
Public Health Service
Division of Water Pollution Control
California and Great Basin Drainage Basins Office

1951

In cooperation with:

California State Department of Public Health
California State and Regional Water Pollution Control Boards
Oregon State Board of Health

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INTRODUCTION

The Federal Water Pollution Control Act, Public Law 845, passed by the 80th Congress in June of 1948, requires the Surgeon General of the Public Health Service to cooperate with other Federal agencies, with State and interstate water pollution control agencies, and with municipalities and industries in the preparation or adoption of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof, and improving the sanitary condition of surface and underground waters.

In developing these programs, due regard must be given to improvements necessary to conserve the Nation's waters for public water supplies, propagation of fish and aquatic life, recreational purposes, agricultural, industrial, and other legitimate uses.

Recognizing the fact that full technical information was not available to permit the development of such comprehensive programs immediately for most of the Nation's waters, the Public Health Service envisioned the development of these programs in two general phases. The first phase contemplated the development of a series of reports, consistent with presently available data, which would: provide a reference point for measuring progress; provide a guide to needed additional data; provide a basis for the logical development of comprehensive programs; provide a basis for approval of loans to States, interstate agencies and municipalities at such time as the Congress made available funds for this purpose; and serve to inform the public on the problem of water pollution and set forth suggestions for pollution control.

The collection of available data as of July 1, 1950, has been completed under the first phase of the program. Such data have been assembled with the cooperation of State and interstate water pollution control agencies. Through these agencies additional data have been obtained from other State officials, county and city officials and representatives of industry. Federal agencies also have been of great assistance. In order to make this information available at the earliest possible moment, these data are being presented in 15 summary-type reports covering the United States by major drainage basins. This report on the California Basins is one of that series.

These summary reports present information about the ways our water resources are used, the pollution going into our water resources and the resulting damages, the benefits which may result from pollution prevention and abatement, the pollution prevention measures now in effect, and those required.

They are prepared in two parts. Part one considers the water pollution problems of the basin as a whole. Part two presents briefly the data for each of the several subbasins of the major basin, including a tabulation of pollution abatement projects now known to be needed for water pollution control.

Since the summary reports are based on data which are now readily available, these reports do not discuss or evaluate the most advantageous water uses as they are related to pollution control. Such considerations will be included as a part of the comprehensive water pollution control programs.

The deficiencies in data and the gaps in information indicated in these summary reports are as significant as the presentation of available facts and statistics. They indicate the work which still needs to be accomplished by water pollution control authorities for the preparation of comprehensive programs.

Data and knowledge now available are sufficient, however, to permit the immediate solution of certain of the pollution problems within the California Basins without awaiting the results of additional surveys and studies. The tabulations of pollution abatement projects which are included in Part Two of this summary report represent presently known needs. However, future studies and evaluations may result in some changes in the estimations of requirements.

A sincere effort has been made by all who contributed to this report to present a fair picture of the complex water pollution problems in the California Basins and to present reasonable conclusions and recommendations. It is our hope that this report, as a step in the cooperative development of an ultimate comprehensive pollution control program, will help in safeguarding the water resources of the California Basins.

Leonard A. Scheele

Surgeon General

ACKNOWLEDGMENTS

The Public Health Service wishes to acknowledge the cooperation and assistance of those agencies and individuals that have contributed to the preparation of this report on the California Basins Drainage Basins.

The California Basins include all of California, except the portions which drain to the Colorado River and to the Great Basin, and those portions of Oregon which drain to the Klamath and the Smith Rivers. The base data used in the report for the Oregon portion of the Basins were provided by the Oregon State Sanitary Authority which also reviewed and cleared the report for Oregon. Similarly, in California the base data and primary review and clearance were provided by the California State Department of Public Health which is the currently designated* "State water pollution agency," for purposes of Public Law 845, 80th Congress.

The 1949 California legislation established a State Water Pollution Control Board and nine Regional Water Pollution Control Boards. Further, the term "pollution" in this legislation is limited to cover any impairment of quality of water that will interfere with a beneficial use but will not cause an actual hazard to public health. An impairment of water quality to a degree which causes a hazard to public health is called a "contamination". State and local health departments are charged with the control of contamination, and regional water pollution boards have jurisdiction over pollution.

Appointment of the Regional and State Water Pollution Control Boards, establishment of their respective offices, selection and appointment of full time staff members, and implementation of the legislative provisions, even though effected with dispatch, have required considerable time. Accordingly, the Bureau of Sanitary Engineering of the State Department of Public Health provided data and has concurred in the conclusions and recommendations of the report. Such concurrence was given with the express understanding that it did not commit the State or Regional Water Pollution Control Boards in any way. Furthermore, as the draft of each Sub-basin report was completed it was referred to the Regional Water Pollution Board concerned for review with a request for comments and such clearance as the Board could give under the provisions of the California law.

The review and clearance of the field offices of the Corps of Engineers, Department of the Army, and the Fish and Wildlife Service, Bureau of Reclamation, Geological Survey, and the National Parks Service, Department of the Interior--Federal agencies concerned with water use programs in the area covered by the report--were also obtained.

Much of the descriptive data used was obtained from reports and publications, too numerous to list here separately, which have been released by State and Federal agencies. Acknowledgment is made for use of all such published data.

Finally, there is acknowledged the assistance of other State agencies and individuals interested in water resources development and conservation, that have contributed information through other sources than those listed above.

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*On March 30, 1951, the California Water Pollution Control Board was designated the "State water pollution control agency", for purposes of Public Law 845, 80th Congress.

SUMMARY

The

This report is intended to furnish information on the current status of water pollution control in the California Basins, pending completion of comprehensive programs for elimination or reduction of pollution for the 13 Sub-basins in the Basins. Data are presented on the sources of pollution, the uses to which the water resources are being put, and the general condition of these waters. An estimate has been made of the adequacy of the existing treatment facilities and of the need for new treatment works, as well as for additions and extensions to existing facilities. An analysis and interpretation of the data assembled in cooperation with the State water pollution control authorities concerned is presented to provide a total view of the water pollution problem for the entire Basins to the extent existing data permit.

Unlike most of the major drainage Basins in the United States, the California Basin lie almost entirely within one State. Since the Basins include all but approximately 200,000 of the 10,490,000 population of California and most of the fertile agricultural land, California State values for agriculture and industrial production are very similar to Basins values and are widely used throughout the report. Only the northerly portions of the Klamath River and Shasta Reservoir Sub-basins are outside of California, in the State of Oregon, and the Oregon portion of the Basins population is only approximately 47,000.

A graphic presentation of the water pollution problems of these Basins is obtainable by reference to the four maps accompanying the report which show by Sub-basins the numbers of sources of pollution, existing treatment works and project requirements, both municipal and industrial, and in addition the primary existing water uses. The pertinent findings from this compilation of available data are given in the sections "Conclusions" and "Recommendations." Detailed data for each of the 13 Sub-basins are contained in Part II of the report, where general descriptive material, comment on the available water pollution data, and tabulation of statistics have been presented.

Economic development of the Basins started with the discovery of gold in 1848 and has continued to be largely dependent upon the abundant natural resources. Although the greater opportunity for economic gain has no doubt been the major factor influencing immigration to California, the healthful climate and the possibilities for outdoor sports and recreation have also influenced many persons to move there.

The abundance of minerals, particularly natural gas and petroleum, has influenced and accelerated the progress of industrial development. The value of all mineral production in 1947 was $855,553,000, of which nearly $700,000,000 was for petroleum, natural gas, and allied products.

The forests of the Basins have contributed much to its economic development. California produced almost four billion board feet of lumber in 1948, ranking third among the States in lumber products, and consumed one-eighth of the lumber produced in the United States during the same year.

Fish and game, as important sources of food, played a significant role in the early development of the Basins and are still important economic factors. Commercial fisheries continue to be a major source of food supply, and the recreational pursuit of fish and game by California sportsmen in 1948 resulted in an expenditure estimated at 259 million dollars.

The gradual upward trend in population of the State of California during the period 1850-1900 has become more pronounced in this first half of the twentieth century, with the population increasing from about 1.5 million in 1900 to 10.5 million in 1950. During the ten year period from 1940 to 1950, the population of the California Basins increased 52 percent, from 6,804,000 to 10,321,000. Much of the increase has been in the Southern Coastal area, particularly in Los Angeles and San Diego; in the San Francisco Bay Area; and in the Central Valley.

The water resources of the Basins are their most valuable natural resource. The annual water crop for the State of California is estimated to average between 70 and 71 million acre-feet, which with an asserted entitlement of approximately 5,000,000 acre-feet of Colorado River water is considered to be sufficient for future needs. There are very great problems of storage and transportation, however, as the supply is not well distributed. In general, there is an excess of water in the northern part of the Basins and a deficit in the southern part.

Irrigated agriculture is by far the most important water use in the Basins. In the Central Valley alone, 8,500,000 acre-feet of irrigation water is used in normal years with 40 percent of the supply obtained from 32,000 wells. There are approximately 5,550,000 acres of land under irrigation in the California Basins at present requiring about 16-2/3 million acre-feet of water per year. It is estimated there is a maximum of nearly 23,000,000 acres of irrigable agricultural land in California.

Although domestic and industrial water supplies are of major importance, the quantity of water required in the Basins for these purposes is estimated to be only about 2,000,000 acre-feet under present conditions. Both the surface and ground waters of the Basins are generally comparatively soft, but the water imported from the Colorado River is so hard that it must be softened before it is acceptable as a domestic supply.

Recreational use of the water resources of the Basins are highly developed and, in some instances, over-exploited. Recreational centers include 23 National Forests that are wholly or partly within the Basins, four National Parks, three National Monuments, and numerous State Parks and Recreational Areas.

Inland navigation in the Basins is of importance only in the lower reaches of the Sacramento and San Joaquin Rivers. Additional channel improvement work has been authorized for the Sacramento River but has not been completed. Water required to maintain navigation also is of value in repelling saline water intrusion into the rich delta area from the Ocean.

There are 97 hydroelectric plants in the Basins with an installed capacity of 2,689,000 kilowatts. The greater portion of these developments are owned by the Pacific Gas and Electric Company; smaller producers are the Southern California Edison Company, and the California-Oregon Power Company. Approximately 450,000 kilowatts of the installed capacity is provided by the Shasta and Keswick plant of the Bureau of Reclamation's Central Valley Project.

The vital importance of water resources has long been recognized in California. Investigations initiated in 1921 led to presentation of the State Water Plan in 1931 which contemplated complete control, regulation, utilization and protection of California's water supply, including water imported from outside the State. Rapid increases in population and industrial development since the original plan was presented have changed conditions, and in 1947 the State Legislature provided for a State-wide investigation of the water resources and revision and completion of the State Water Plan. This investigation is now being conducted by the State Water Resources Board, and will provide an accurate picture of the adequacy of the water resources when published during the fiscal year 1951-52. When this report is published, current factual data will be available as to the adequacy of the State's water resources for future growth. It is generally believed the total water crop plus the asserted entitlement to Colorado River water will assure an adequate supply, but there are very great unsolved problems of storage and transportation due to the excess of water in the north and the deficit in the south.

Available information indicates that in 1950 liquid wastes with a known population equivalent of approximately 11,520,000, were being discharged to the water resources of the Basins from 529 sewered communities with a connected population of 8,423,000 and from 83 known industrial plants discharging industrial wastes through separate outlets. About 24 percent of these wastes are discharged to watercourses, 8 percent to land, and 68 percent to the Pacific Ocean or tidal salt waters. The above figures do not include the waste population equivalent for 297 known industrial plants with organic waste discharge, and 62 industrial plants with inorganic waste discharge for which information is too incomplete to permit an estimate of the population equivalent of wastes discharged. The information on population connected to municipal sewerage systems is believed to be fairly complete, but the information concerning the population equivalent of industrial wastes discharged to municipal sewerage systems and for industries with separate waste discharges is so incomplete that tabular summarization of available data on industrial waste treatment plants has not been attempted. Wastes from the rural population not connected to domestic sewerage systems and from agricultural operations, including turbidity from soil erosion and highly mineralized return irrigation water, also pollute the water resources.

The principal types of damages that have resulted from water pollution in the Basins are:

(1) Health hazards from contamination of surface and ground waters used as sources of public water supply.

(2) Loss of wells due to marine and oil well brine intrusion.

(3) Economic loss due to pollution of irrigation water supplies restricting the type of crops that can be grown.

(4) Direct and indirect losses resulting from closing of polluted beaches. Depressed property values in the vicinity of polluted waters.

(5) Increased costs of treating water supplies for domestic and industrial water uses due to pollution and turbidity from soil erosion.

(6) Fish kills and blocks to migrating fish due to reduction in oxygen content of streams receiving organic wastes. Loss of ducks and other wildlife from infections contracted from polluted waters. Loss of fish life from mine and lumbering operations.

(7) Damage to metal and paint on ships, buildings and bridges in areas where septic conditions result from complete oxygen depletion of polluted waters.

Benefits that have resulted from pollution prevention and abatement are often intangible, and the actual dollar value may be difficult to estimate. Where water is as essential as in the California Basins, it is important that none of the water resources be lost through pollution. In fact reclamation and reuse of the polluted water resources in many instances will be cheaper than importation of water. Pollution control measures that have already been adopted have permitted lifting the quarantine on many miles of Ocean beaches and have improved some of the worst conditions in the Basins. Perhaps the greatest benefit that can be expected from pollution control is the maintenance of the present quality water resources in areas not yet seriously affected by pollution.

Four hundred and thirty-eight of the 529 sewered communities in the Basins have provided waste treatment facilities. Primary treatment is provided by 198 plants for the wastes of a combined population of approximately 3,356,000 from 244 communities. One hundred and sixty-seven secondary sewage treatment plants serve a combined population of approximately 3,024,000 of 194 communities. Information on industrial waste treatment is incomplete, but 199 of the 443 industries in the Basins known to be discharging wastes to watercourses through separate outlets have provided waste treatment facilities. For another 195 industries, no determination has been made concerning the provision of waste treatment facilities.

It is significant that 83 percent of the sewered communities and 76 percent of the sewered population are served by waste treatment works as compared to national averages estimated at 65 and 63 percent, respectively. The Shasta Reservoir, Kings and Kern Rivers and Tulare Lake, Santa Clara River, Los Angeles River, and San Diego Sub-basins lead in the construction of municipal sewage treatment plants with 100 percent of the sewered communities served by sewage treatment facilities. The Los Angeles River Sub-basin leads in the degree to which effective pollution prevention measures have been adopted with 99.7 percent of the sewered population of approximately 3,949,000 served by adequate waste treatment facilities.

Good pollution abatement progress has been made in the Basins in recent years indicated by the construction, from 1946 to July 1950, of 101 municipal plants to serve a combined population of 5,870,000. In addition several industrial waste treatment plants have also been constructed during this period, but information is incomplete as to what has been accomplished by industry. Much of the activity in community sewage plant construction has been stimulated by the availability of State funds to communities on a matching basis for postwar construction of needed public works.

Presently available information indicates that 204 municipal sewage treatment construction projects are needed in the California Basins. 142 of these needed projects, to serve a population of about 2,386,000 are for new plants and for replacements of existing plants now obsolete. Sixty-two of the projects are for enlargements or additions to existing plants which now serve a population of 369,400. Of these municipal projects 31 would serve communities with populations of 500 to 1,000; 72 would serve populations of 1,000 to 5,000; 28 would serve population of 5,000 to 10,000; 34 would serve populations of 10,000 to 50,000, and 6 would serve populations of over 100,000.

The cost of community waste treatment facilities needed in the Basins is difficult to estimate since the cost of each project in the California portion of the Basins will depend upon the degree of treatment necessary to meet the requirements being developed by the Regional Water Pollution Control Boards. The new California Legislation requires that orders issued by a Regional Water Pollution Control Board shall not specify the design, type of construction, or particular manner in which an operation threatening to cause a condition of pollution or nuisance is to be corrected. Under present conditions, the cost of sewage treatment works may vary from $10 to $60 per capita, depending upon the design capacity of the plant and the type of treatment provided.

Of the 443 known industrial plants with separate waste discharges, nine require new waste treatment plants, six require enlargements or additions, one requires replacement, and 38 require no improvements on the basis of present information. Requirements of the other 389 industrial plants, or 88 percent to the total, are undetermined, and investigations will be required to determine the pollution prevention measures necessary. Before an estimate of the cost of needed industrial waste treatment plant construction can be made, much additional information on industrial waste discharges, present water quality and present water uses must be obtained.

The San Francisco Bay Sub-basin with only 56 percent of its 132 communities and 26 percent of its 2,242,000 population served by treatment works, is the area where the least pollution control work has been done.

Surface drainage crossing the Mexico - United States boundary on the south of the Basins and the Oregon-California boundary on the north has aroused interest in the use of these waters and concern over the pollution discharged to them.

In addition to the construction program required for pollution control, a comprehensive study of industrial waste problems, research

Table I—California Basins
Summary of municipal sewage treatment plant data from tables A, C, E, G.

Sub-Basin	Sewered communities			Treatment facilities			Sewered population				
	Total number	With treatment		Total number	Adequate		Total number	With treatment		Treatment adequate	
		Number	Percent		Number	Percent		Number	Percent	Number	Percent
Klamath River...	15	14	93	15	9	60	40,790	39,425	97	12,410	30
Shasta Reservoir	5	5	100	5	2	40	11,900	11,900	100	5,000	42
North Coastal...	19	13	68	13	8	62	69,375	41,575	60	22,200	32
Sacramento River	46	38	83	38	25	66	266,040	101,394	38	68,084	26
San Francisco Bay............	132	71	54	57	29	51	2,420,675	636,650	26	558,350	23
San Joaquin River..........	59	51	86	51	32	63	314,920	297,220	94	159,175	51
Salinas River and Central Coastal Streams........	38	35	92	32	23	72	161,025	155,625	86	113,400	63
Kings and Kern Rivers and Tulare Lake...	45	45	100	45	30	67	164,305	164,305	100	88,085	54
Santa Maria and Santa Ynez Rivers.........	13	11	85	11	9	82	59,550	55,550	93	18,000	30
Santa Clara River..........	10	10	100	10	5	50	75,490	75,450	100	32,300	43
Los Angeles River..........	60	60	100	9	5	56	3,948,750	3,948,750	100	3,936,500	99.7
Santa Ana River.	45	45	100	36	25	69	336,710	336,710	100	165,740	49
San Diego........	42	40	95	43	30	70	533,495	514,895	97	463,405	87
California Basins totals.	529	438	83	365	232	64	8,423,185	6,379,449	76	5,640,179	67
United States average*......	—	—	65	—	—	—	—	—	63	—	—

*Excerpt from "Statistical Summary of Sewage Treatment in the United States" (1963).

into water quality requirements for specific uses, research, including pilot plant studies, of industrial waste treatment methods, and a continuing Basin-wide sampling and analytical program to ascertain water quality are required for a sound pollution abatement program in the Basins.

CONCLUSIONS

1. The phenomenal growth of California in the last decade has brought such increased demands for water for domestic, industrial, agricultural and other uses as to leave no question concerning the need for wise utilization and conservation of the State's water resources if its growth is to continue.

2. Studies by the California Division of Water Resources indicate that California's water resources, including its rights in the waters of the Colorado River, can be developed to meet the probable ultimate requirements of the State.

Development of the water resources to meet these ultimate requirements will involve transfer of water from one Sub-basin to another and eventual utilization of all available resources.

Control of water pollution to a degree sufficient to avoid any loss or waste because of impairment of quality is an essential part of the development program.

3. In some Sub-basins importation of water from other Sub-basins may be extremely costly. Reclamation of liquid domestic and industrial wastes for industrial, agricultural and other uses may prove economical in such areas and a valid conservation measure.

4. Current estimated annual water requirements in the Basins for irrigated agriculture are 16.7 million acre-feet, far outranking all other water use requirements. Water used for domestic and industrial purposes is approximately 10 percent of this. In addition, waters of the Basins are used to operate 97 hydroelectric plants with an installed capacity of 2,689,000 kilowatts. They are also used for valuable sports and commercial fisheries; for recreation, including bathing, boating, camping and fishing; and for navigation.

5. The use of sewage effluents and waters contaminated by domestic wastes for irrigation is common in areas of the Basins where water is very scarce. To date no cases of water-borne disease have been traced to the use of contaminated irrigation water, but some economic loss results from Health Department restrictions on the crops that can be irrigated with such waters.

6. Surface drainage crossing the Mexico-United States boundary on the south and the Oregon-California boundary on the north results respectively in international and interstate interest in the use of these waters and concern over the pollution discharged to them.

7. There are gaps in the information needed by pollution control agencies, particularly regarding industrial wastes, to aid them in the location of sources of pollution, the evaluation of damages to water resources, the determination of desirable water quality criteria, the establishment and administration of minimum regulations for disposal of wastes, and the supervision of treatment plant operation.

8. Public information programs are not being widely used by State governmental agencies and interested lay groups to keep the people of the Basins informed on pollution abatement problems.

9. Water resources development projects which determine principal water uses or which change stream flow conditions will influence the requirements prescribed by pollution control authorities for treatment of wastes discharged to these water resources.

10. Land mismanagement favoring soil erosion is responsible for excessive silt loads in many streams and damage to such streams and related reservoirs.

11. Domestic and industrial waste discharges to surface and ground waters have caused damages to community, industrial and agricultural water supplies, fish and wildlife, and recreational facilities throughout the Basins.

12. Some of the benefits which can be expected to result from pollution control are: elimination of health hazards through improvement of contaminated domestic and irrigation water supplies; economic gains from reclamation of polluted waters for beneficial use; increase in property values in areas where shoreline property values have been depreciated in the past by nuisance conditions; protection of water quality to assure continued economic expansion and protection of aquatic and wildlife.

13. It will require some time for the new Regional Water Pollution Control Boards to prescribe requirements for the communities and industries with waste disposal problems in the California portion of the Basins. However, there are many communities and industries that already know their pollution abatement needs.

RECOMMENDATIONS

1. Communities and industries which have studied their waste treatment problems and have developed specific programs for solving them and those for which requirements have been prescribed by State pollution control authorities, should proceed at once with construction of facilities for control or treatment of their wastes.

2. Comprehensive investigations should be carried on in the California portion of the Basins by the Regional Water Pollution Control Boards to fill the present gaps in information on pollution sources and damages therefrom, so that in prescribing requirements for any particular condition of pollution or nuisance the Regional Boards may have the advantage of this region-wide knowledge of problems and needs.

3. A particular effort should be made by local, State, and Federal agencies concerned with water pollution control to acquire adequate information on industrial waste discharges.

4. Construction of reservoirs and other water resources development projects should be preceded by a careful analysis of their probable effects on water quality and waste treatment requirements in relation to proposed water uses.

5. Public information programs should be expanded and strengthened through cooperative effort by local, State and Federal governmental agencies and civic lay groups, to inform the people of the Basins of specific needs for pollution control through waste treatment, in order to gain public support for conservation of the water resources of the Basins.

6. The present informal cooperation between the Oregon State Board of Health and the California Department of Public Health with regard to water pollution problems in the interstate Klamath River Sub-Basin should be strengthened and extended to include participation by the North Coastal Regional Board of California.

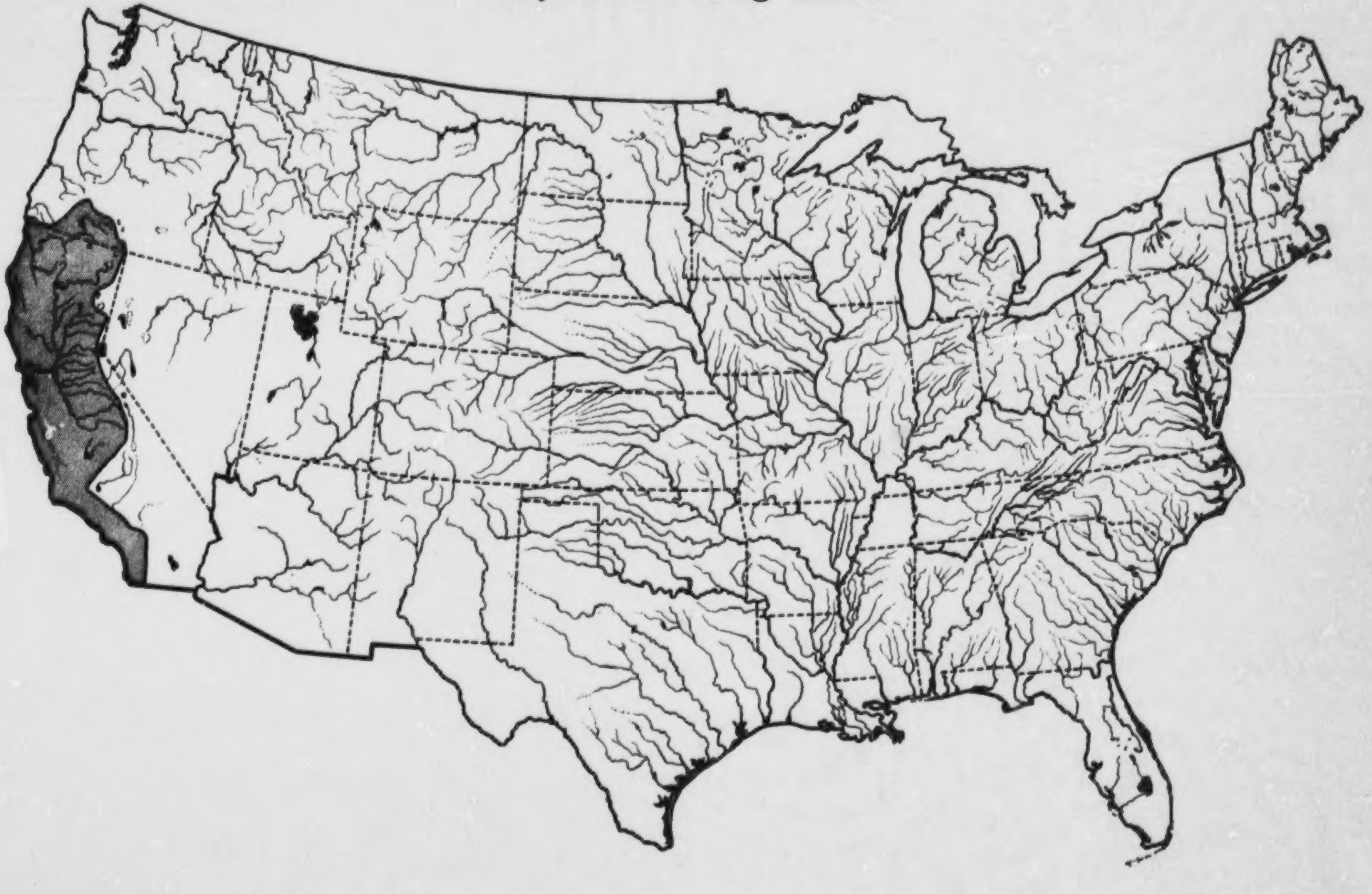
7. The International Boundary and Water Commission, United States and Mexico, should seek to bring about coordination of activities of Mexican and California agencies now studying the Tijuana-San Ysidro sewage disposal problem in order to secure joint action and a reasonable solution of this international problem.

8. The program for research in technical problems of disposal of sewage, garbage and industrial waste initiated by Chapter 1575 of the California Statutes of 1949, should be continued and adequate financial support provided to permit conduct of investigations aimed at developing economical and practical methods for treatment and reclamation of wastes.

9. Studies should be continued by local, State and Federal agencies on the extent of marine and oil well brine intrusion, and the effect of land disposal of domestic and industrial wastes on subsurface water quality.

LOCATION MAP

California Drainage Basins



GENERAL DESCRIPTION

Historical Background

The name California was used about 1500, perhaps for the first time, by the Spanish writer Montalvo in a part of his famous romance, "Amadís de Gaula", that tells of a rich island utopia, called California, with a queen Calafia. The name of this utopia has been definitely linked with the name of the State.

Probably the first Spaniard to set foot on California soil was Rodriguez Cabrillo whose expedition discovered San Diego Bay on September 28, 1542, and explored the coast as far north as Point Reyes, Marin County. On nearby Drakes Bay, Sir Francis Drake landed in 1579, named the territory New Albion and claimed it for England. Twenty-three years later, Sebastian Vizcaino explored the California coast and named many of its landmarks.

Spanish colonization began in 1769 with the arrival at San Diego of the land and sea expeditions of Gaspar de Portola. The same year marked the beginning of the establishment of the famous Franciscan Missions of California, with the founding of Mission San Diego de Alcala on July 16. In the following November, Sergeant Ortega, from Portola's overland expedition in search of Monterey Bay, discovered the land-locked anchorage of San Francisco Bay, but it was not until 1776 that the expedition of Moraga founded the Mission San Francisco de Assisi. A few miles further north in Sonoma County--then occupied by native Indians called the Chocuyens--Mexico, in 1823, planted the End of the Mission Trail known as Mission San Francisco de Sonoma, the last Spanish colony in California. Seven national flags have waved over this Mission, more than have flown over any other political subdivision in the New World. It is the birthplace of the Bear flag, now the ensign of the Golden State and the emblem of the Native Sons of the Golden West. From this area came the wheat for the first regular export cargoes of grain ever carried by vessels from the western shores of the Americas. Here occurred the Bear Flag Revolt in 1846, when a small group of American settlers encouraged by Captain John C. Fremont, captured the famous California patriot, General Vallejo, and proclaimed the "California Republic."

During the period 1769-1822 a pastoral civilization developed in the fertile hills and valleys near the coast and isolated from both the Old and New Worlds. The year 1812 marked the beginning of the Russian settlement from Alaska that was established at Fort Ross, about 75 miles north of San Francisco. This Colony lasted only until 1841, being terminated by the general colonizing pressure of that period.

Mexican rule began in 1822, and was followed by the influx of traders and pioneer American settlers led by such trail blazers as Jedediah Smith, James Pattie, and Joseph Walker. The expeditions of Captain John Fremont in 1843 and 1845 were followed by the Bear Flag revolt in 1846 and war with Mexico, which lasted until 1848 when gold was discovered on the American River in El Dorado County. Thereafter an influx of settlers caused economic expansion and development. California was admitted to the Union as the thirty-first State on September 9, 1850. It was not until 1879, however, that the present State Constitution was adopted.

Gold and railroads did much to make history in California during the last half of the nineteenth century. The completion of the Central Pacific Railroad in 1869 provided the first transcontinental rail link between the East and West, and marked the beginning of a new era of development of the great agricultural resources in the northern section of the State. A corresponding impetus to the agricultural resources of Southern California was provided by the Southern Pacific Railroad line to Los Angeles, which was completed in 1876.

The modern phase of California's economic history began during the period 1910-1915. It was characterized by the beginning of large scale manufacturing and by the expansion of irrigated agriculture, of automotive travel, and of the oil and motion picture industries. These developments were accelerated by opening of the Panama Canal in 1915, providing new transportation links and a new structure of competitive rail and water freight rates.

Over 62 percent of the dwellings in the State have been built during the last two decades. Population and economic increases have accompanied the harnessing of the Colorado River water, the waters of the Central Valley, and the lesser watercourses for hydroelectric power and for agricultural uses. These developments and the absorption of vast numbers of immigrants have accentuated the needs for water in California and the importance of conserving the quality and quantity of natural supplies.

Physical Description

The California Basins have an area of about 111,000 square miles and embrace all of the diverse watershed areas of the Pacific Coast from the Smith and Klamath River watershed on the north to the Mexican border on the south. They are separated from the Great Basin by the principal coastal ranges of the Pacific, namely, the Cascades, the Sierras and the Peninsular Mountains, extending along the entire eastern side of the Basins. On the western side near the Pacific Coast the Basins are traversed by the parallel Coast Range Mountains. These two major parallel mountain systems converge at Mount Shasta on the north and at the Tehachapi Mountains on the south. They enclose the fertile, Central Valley which is a sloping and practically unbroken plain about 400 miles long and 80 miles long and 80 miles wide.

The length of the coastline of the Basins approximates 1,000 miles, equivalent to about three-fifths of the western coastline of the United States, while the width of the Basins varies from 50 to 200 miles.

This drainage area possesses remarkable combinations and contrasting extremes of topography, climate, soils, minerals, and plant-animal community types. Likewise, there is a corresponding diversity of population density, of levels and types of economic and social activities, and of climatological and physical conditions.

In the northern sector there are the two afore-mentioned mountain systems--the Coast Range and the Cascades. The main headlands of the precipitous coastal shoreline are Cape Mendocino, Point Arena, and Point Reyes. The principal coastal streams are the Smith, Klamath, Eel, Navarro, and Russian Rivers. Inland, between the Coast Range and the Cascades, lie the Sacramento River and the upper portion of the Great Central Valley of California.

The central third of the Basins include the San Joaquin River and a southern extension of the fertile Central Valley with several additional small--but rich agricultural valleys; irregular Coast mountains, running northwest to southeast; and, in addition, the estuarine water system of the San Francisco Bay area.

The southern part of the Basins include the most fertile coast land of the State and, further inland, the rugged Peninsular Range Mountains that extend northward into California from Mexico. The principal internal watercourses have seasonal flows and include the Santa Ynez, Santa Clara, Los Angeles and Santa Ana Rivers.

Rainfall varies from over 100 inches in the high mountains of the northern part to eight inches or less at the low levels in arid regions of the southern part of the Basins. The High Sierra Nevada snow accumulations, 35 to 40 feet in depth and about the greatest in the United States, are an economically important, constant source of water for cities, hydroelectric and irrigation purposes. Winter months are characteristically wet and cool, while the mid-summer months are dry and warm.

Temperatures vary greatly, depending upon latitude, altitude and proximity to the ocean. In the equable climate of the low-lying coastal area at San Diego (elevation 87 feet), the average maximum and minimum annual temperatures are 67.7 and 54.7°F., respectively; while at Seven Oaks in the San Bernardino Mountains (elevation 5,000 feet) corresponding temperatures are 65.6 and 34.5°F. At low coastal and high inland locations of the northern part of the State, average maximum and minimum annual temperatures at Eureka (elevation 62 feet) are 57 and 46.2°F., respectively; while at La Porte, Plumas County (elevation 5,000 feet), corresponding temperatures are 55.5 and 33.7°F.

Economic Development

Historically and currently, economic expansion in the California Basins is exceptionally dependent upon extensive and varied natural resources. Natural alpine lakes, artificial reservoirs, natural and artificial watercourses, ponds, rivers and streams, bays and harbors unite to form a great surface network that, since the pioneer days, has facilitated economic expansion through the provision of transportation, recreation and the utilization of commercial resources. Economic considerations, starting with the discovery of gold in 1848, have brought waves of westward migration to California. The gradual upward trend in population of the period 1850-1900 has become more pronounced during the first half of the twentieth century, with the population increasing from about 1.5 million in 1900 to 10.5 million in 1950. This trend characterizes these drainage Basins, the population of which is about 10,321,000. The Basins increase of about 52 percent since 1940 has been largely the result of population movement resulting from World War II and has greatly increased the urbanization of the State.

Agriculture in the California Basins, largely dependent now upon irrigation waters, has developed through three successive stages: cattle ranching of the early days, dry farming of small grains and fruit, and the present day specialized and intensified irrigation farming. Demands for agricultural products, particularly in central and northern California, increased rapidly during the last half of the last century. At that time, California's newly found mineral wealth brought great numbers of immigrants.

Irrigation, practiced first in California by the Spanish missions in the 18th century, did not become widespread until the period 1870-80. Since then, irrigated agriculture has dominated agricultural economics in the State, and this, of course, applies to the Basins. Recent estimates indicate that there are approximately 6 million acres of land in California under irrigation. About 450,000 acres of this land is in the Imperial and Coachella Valleys outside of the California Basins. Hence, at 3 acre-feet per acre, the annual irrigation water usage in the Basins is about 16 2/3 million acre-feet.

In 1945, the farm population of the State was about 539,000, the number of farms, 138,917; the average size of the farms, 252.3 acres; the value of the farms of the State, nearly 3.5 billion dollars; and 35 million acres of land were in farms, most of which are within these drainage Basins. Fruits, nuts, various truck crops, and highly specialized field crops are produced in the numerous fertile valleys in exceptionally large quantities. In 1945, the total agricultural production values approached one and one-half billion dollars.

Since 1940, due to "war boom" conditions, farm land values in the Basins have greatly increased. In California, the index of farm real estate values has increased from a calculated value of 121 for 1940 to 219 for 1946. These developments have accompanied or, in many instances resulted from, rapid improvements in air transportation, quick-freezing, and in the increasing utilization of plastic and other synthetic materials from farm products. A major factor in the Basins' economic development has been the improved availability and utilization of natural waters through the operation of new storage and flood control reservoirs, of which there are 692 under the supervision of California, with an aggregate storage capacity of 7.5 million acre-feet, and at least 32 owned or operated by the agencies of the United States and having a maximum total storage capacity of nearly 8 million acre-feet.

The California Basins' early as well as recent economic expansion has been profoundly influenced by a great variety and quantity of highly valuable and readily accessible mineral resources. Most of California's mineral output, valued at over 855 million dollars in 1947, is produced in these Basins. Petroleum and gold are the two most important deposits. There exist in the Basins approximately 500 different types of minerals. Of the 70 or more minerals produced in commercial quantities, 25 have reserves expected to last 50 years or longer. These minerals include: gold, cement materials, iron, clay, silica and magnesia.

Gold was discovered at Coloma, Calif., in 1848, quicksilver was mined in 1850, coal in 1861 and the production of borax, sulphur, chromite, lead, and silver followed during the next decade. Gold was the dominant factor in producing economic growth during early California history. Its position of eminence has since given way, in the field of minerals, to petroleum which, with natural gas, is now the number one mineral of California, with gold and cement second and third on an all-time rating. The value of petroleum, natural gas and allied products produced in California during 1947 was nearly 700 million dollars.

The natural gas and petroleum fields lie principally in the southwest coastal area and in the southern San Joaquin Valley. Gold deposits are mostly in the northern counties, particularly in the Sacramento River Sub-Basin.

Fish and game play a less direct economic role than minerals, but they have been major factors in the past economic progress of the State. The commercial fisheries, which began with the salmon that supplied a major source of food in the early Sacramento mining camps, now include a great diversity of species and uses and the largest State poundage in the nation, frequently totalling over one billion pounds. The economic development of the commercial fisheries has, however, undergone serious declines in the instance of particular species in several areas. Hydraulic mining, in past years, has modified the fresh water habitat of salmon and seriously reduced the potential supply. Extensive dam construction, completed and contemplated, presents a menace to all migratory fish life. Formerly, San Francisco Bay was a rich source of shellfish--clams and oysters. With the advent of industrial development and consequent water pollution, the shellfish have completely disappeared. Currently, the major opportunity for commercial fish development lies in oceanic fishery.

Recreational pursuit of fish and game has great indirect economic value to the State. Since pioneer days, most species have seriously declined in numbers and certain ones, such as the grizzly bear and the passenger pigeon, have become extinct. Deterioration of habitat and increased hunting pressures have been largely responsible. The number of licensed anglers increased from under 300,000 in 1936 to about one million in 1948. In 1948, according to the California Division of Fish and Game, the pursuit of fish and game for sport brought about the expenditure by California sportsmen of an estimated 259 million dollars.

The forests of California, once apparently limitless, are now greatly reduced. They have contributed much to the economic development of the State. California possesses about 45.5 million acres of forest lands which is 7.3 percent of the national total. The area of commercial forest land is 16.4 million acres. In 1949, California ranked third in lumber production and was the highest per capita consumer of lumber in the Nation, using one-eighth of the national production. Since 1940, utilization of timber has increased

rapidly as indicated by the increase in number of sawmills from 400 to nearly 1,000 in 1949, and in amount of lumber produced from two billion board feet in 1940 to four billion in 1948.

The rapid economic development and utilisation of the timber resources has been compensated for in part by the application of improved methods of forest management practices. There remains, however, the increasingly important need for guarding the present excellent quality of the aquatic environment in all timbered areas against pollution by the expanding lumber operations.

USES OF WATER RESOURCES

The California Statutes of 1947 provided for a State-wide investigation of water resources, presently being conducted by the State Water Resources Board. The investigation requires a revision and completion of the State Water Plan. The latter was presented in 1931 as the fruit of investigations initiated in 1921 under legislative authority. The State water plan contemplated complete control, regulation, utilization and protection of California's water supply as well as importation of supplies into the State. It is expected that the report resulting from the present investigations of the State Water Resources Board, will be published during fiscal year 1951-52.

California's average annual water crop has been reported to average between 70 and 71 million acre-feet which with some 5 million acre-feet additional from the Colorado River, has been considered sufficient for the State's ultimate future needs if made available where needed. However, 41 percent of the water crop is produced in the North Coastal area, 48 percent in the Central Valley, and the balance in the rest of the State.

As is to be expected in a Basins having the varied geographic and climatic conditions that occur in the California Basins, the State's water resources are applied to all the important water uses. Both surface and underground waters are utilized for domestic, industrial and agricultural water supply. Coastal and inland surface waters are used for propagation of fish for sport and commercial purposes. In game refuges, in National and State parks and forests wildlife requires water for its well-being. Recreational uses of water are made from the northernmost Klamath River Sub-Basin in Oregon to the southern border of California, and include: fishing, hunting, swimming, boating, camping, picnicking, and winter sports. Navigation uses include numerous coastal harbors and the Sacramento and San Joaquin Rivers to Sacramento and Stockton, respectively. Hydroelectric power development by private enterprise and by city and Federal governmental agencies has grown, as the State has developed, to meet the constantly increasing needs for electric power.

Domestic and Industrial Use

Statistics of the California Department of Public Health show that there are over 600 public water supplies in the State derived from surface and ground sources, exclusive of numerous small systems for which information is incomplete.

In addition, there are numerous industries in the State notably fruit, vegetable, and fish processing plants, oil refineries, electric generating steam plants, wineries, chemical industries, and beet sugar plants, to name some of the largest, which have developed their own water supplies from surface and ground sources.

Specific information on the total annual water requirements for domestic and industrial use in the California Basins is incomplete and accurate consumption figures are not readily available. It has been estimated that the Central Valley and the San Francisco Bay area, which imports water from the Central Valley Basin, utilize some 700,000 acre-feet of water annually for domestic and industrial purposes. The population represented in these areas approximates 3,625,000. If this ratio of water use to population is applied to the entire population of the Basins the total annual consumption for domestic and industrial use in the Basins would be about 2 million acre-feet, a daily per capita consumption of about 175 gallons.

Agricultural Use

The State engineer has estimated the ultimately irrigable land in California at nearly 23 million acres out of a total State area in excess of 100 million acres, whereas 6 million acres are estimated to be irrigated now in the State. The ultimate irrigation needs at three acre-feet per acre are, therefore, about 69 million acre-feet. Compared to current useage of about 17 million acre-feet at three acre-feet per acre, it is evident that with this estimated ultimate requirement as compared to the total resources (some 76 million acre-feet), irrigated agriculture rates far above all other uses as to order of magnitude of the needs.

It is significant to note the great importance of the underground water resources in these Basins. In the Central Valley, for instance, where during normal years some 8,500,000 acre-feet of water are used for irrigation, approximately 40 percent of the supply is obtained from the underground basins through over 32,000 wells.

Control of the mineral quality of irrigation water is of the utmost importance to irrigated agriculture. Use of sewage effluents or contaminated water for irrigation of food crops eaten raw is a potential health hazard, and large areas of the United States might be affected because of the nation-wide distribution of California-grown crops. A relatively high concentration of certain dissolved salts such as sodium and boron is harmful to plant growth and to soils. The effects of such salts are significant aspects of the problem of quality control of water for agricultural use.

Recreational Use

All major water uses for recreation in the California Basins are highly developed and, in some instances, over-exploited. Fishing is a major recreational as well as commercial use. Sportsmen fish in the rugged, scenic, mountain streams and lakes, in the warmer waters of valley rivers and bay tributaries, in the estuarine waters of coastal bays and harbors, and in the Ocean surf along hundreds of miles of coast. In California there has been a pronounced upward trend in the amount of sport fishing. Total angling license sales doubled between 1935 and 1941 and then redoubled between 1941 and 1948, when the yearly number approached one million. Intense sport fishing in mountain streams, for example, makes necessary artificial stocking of legal sized fish, produces congested conditions in the adjoining recreational areas, and greatly intensifies the ever present pollution hazards.

The maintenance of maximum use of the streams for the fisheries depends on the preservation of satisfactory minimum flows, on the absence of pollution on the spawning grounds, on a minimum disturbance of the natural brackish water gradients in the lower reaches of the rivers, and on maximum use of canal screens, fish ladders and other devices needed to compensate for the disturbance of the natural environment. Favorable natural conditions for cold water species exist in the mountains. At intermediate altitudes, dams adversely affect the migrations of anadromous species and reservoirs threaten the survival and growth of certain more valuable species. In the lower reaches of the rivers, changing flows and abnormal salinity ranges threaten normal levels of production.

Boating, hunting, camping, and picnicking along the extensive watercourses of the Basins attract hundreds of thousands of people annually to the famous scenic areas. These recreational centers include 23 National Forests which are wholly or partially within the Basins, four National Parks, three National Monuments, and numerous State Parks and Recreational Areas.

All reservoirs of sufficient size are used for boating and swimming where such use is not prohibited. Generally the banks or shorelines are without adequate sanitation facilities and in many cases even minimum facilities are lacking. The owners or management agencies of reservoirs developed for power or irrigation in many instances have shown little concern for recreational use of these areas, and where such reservoirs are in private ownership sanitation facilities are usually entirely lacking.

Commercial Fishing Use

Commercial fishing for anadromous species centers in San Francisco Bay with its principal tributaries, namely the Sacramento and San Joaquin Rivers, and along the coast. According to the U. S. Fish and Wildlife Service, the full potential commercial value of salmon and steelhead trout (sport fish only) runs in the Central Valley streams has been calculated to be over $2,000,000 per year. In addition, there are minor commercial fisheries for shad and catfish and important sport fisheries for striped bass, steelhead trout, salmon, catfish, black bass, and sunfish.

The marine shore fisheries are used extensively both by the sport fisherman and the commercial fishermen. Early in the century the waters of San Francisco Bay were used for shellfish culture. Industrialization of recent decades, with accompanying inadequately controlled pollution, has terminated this important water use.

Power

Extensive hydroelectric power developments have been carried out in the California Basins to meet continually increasing demands. There is a total of 97 hydroelectric plants in the Basins with an installed capacity of 2,689,000 kilowatts. By far the greater portion of these developments are owned and operated by the Pacific Gas and Electric Company. Other producers are the Southern California Edison Company, serving users in the southern part of the State, and the California Oregon Power Company with power developments in the Klamath River area. Approximately 450,000 kilowatts of the installed capacity is provided by the Shasta and Keswick plants of the Bureau of Reclamation's Central Valley Project.

Most of the hydroelectric power of the Basins is produced at plants located north of the Tehachapi Mountains; approximately 80 percent is from plants located in the Central Valley Region.

Navigation

Inland navigation is of principal importance in the Central Valley of California. Ocean-going vessels have access to Stockton, on the San Joaquin River via a deep water channel and a similar deep channel, now only ten feet in depth, is to be built to Sacramento on the Sacramento River. These channels are within the tidal influence of the Ocean and require little or no extra water for their operation. It is proposed to restore the Sacramento River

above Sacramento for navigation by providing certain minimum navigation flows from Shasta Reservoir of the Central Valley Project through supplemental channel works. A considerable portion of the water required in the Sacramento River for navigation can also be utilized to satisfy downstream requirements for irrigation and salinity control. Reduction in the water supply for irrigation and municipal use would result, however, if the navigation demands are fully met, as some releases exclusively for navigation would then be required. Existing primary water uses are indicated on Map No. 4.

POLLUTION CONTRIBUTED TO WATER RESOURCES

Available information for municipal and industrial sources of pollution is summarized in Tables A and B. In the California Basins there are 529 population centers served by sewerage systems having a connected population of about 8,423,000. One hundred and fifty-six of these, serving 844,000 persons, discharge wastes with an estimated population equivalent of 1,729,430 to watercourses; 164 serving 570,500 persons, discharge wastes with an estimated population equivalent of 679,000 to land; and 209 serving 7,008,800 persons, discharge wastes with a population equivalent of 6,314,600 to the Pacific Ocean and its bays and tidal estuaries. Wastes which are contributed to municipal sewers from industries, for which information is available, increase the actual organic equivalent loadings on the systems discharging to watercourses, land, and the Ocean by 1,479,000; 551,000; and 3,404,000, respectively.

In addition, there are 83 industries which discharge organic wastes through separate outfall sewers and contribute an estimated population equivalent of 2,797,000 to the fresh and salt waters of the Basins. There are also 297 industrial plants of the above type for which data are not available, 62 others producing inorganic wastes, and one for which the character of the wastes is undetermined.

These statistics indicate that the total known liquid organic wastes as discharged by sewered communities and industries are equivalent to the untreated wastes of approximately 11,520,000 people. About 24 percent of these wastes are discharged to watercourses, 8 percent to land, and 68 percent to the Ocean.

Use of the industrial statistics presented in Table B should be made only after consideration of the conditions of compilation and sources of the information. The industries tabulated are only those which are known to have separate waste discharges. Many of the significant sources of industrial wastes in the Basins lie within the well-sewered metropolitan districts of San Francisco, Los Angeles, San Diego, and some of the larger Central Valley cities and do not have individual waste discharges. The industries considered were those for which information was available in the files of the State Department of Public Health by reason of investigation of complaint, application for permit to discharge wastes or as a result of special studies or investigations. Thus, it may be assumed that the largest potential industrial waste problems have been considered although the information is admittedly incomplete.

The organic industrial wastes originates primarily from fruit and vegetable packing and processing plants and the inorganic wastes from oil production, mining and chemical industries. Concentrated industrial waste contributions are found in the San Francisco, Monterey Bay, Los Angeles and Central Valley areas. Industrialization of these Basins is extensive and much field work and surveys of industrial activity are necessary to secure an adequate appraisal of the total industrial waste problem in the Basins.

The breakdown of numbers of sources of municipal and industrial pollution by Sub-basins is shown on Map No. 1 entitled "Sources of Pollution." The detailed statistical data concerning sources of pollution in each of the 13 Sub-basins are presented in Tables A_1 to A_{13} and B_1 to B_{13} in Part II of this report.

Table A. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)***
Having data on pollution load discharged to watercourse	"To watercourse" ** 156	843,820[1]	1,729,430
	"To land" ** 164	570,545[2]	679,075
	"To ocean" ** 209	7,008,820[3]	6,314,635
Having population data available (Data on pollution load to watercourse incomplete or not available)	--	--	Not applicable
Total	529	8,423,185	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

**In the California Basins sewage collection and treatment systems discharge not only to watercourses where pollution of surface waters may be a problem but also to land where pollution of underground waters may occur and to the ocean where adequate dilution simplifies disposal. Accordingly, the sources of pollution are broken down into these three categories and listed as such in this table.

***Includes industrial wastes discharged into municipal sewerage systems.

[1] Industrial wastes with a population equivalent of 1,479,000 increase this value to a population equivalent of 2,322,820.

[2] Industrial wastes with a population equivalent of 551,000 increase this value to a population equivalent of 1,121,545.

[3] Industrial wastes with a population equivalent of 3,404,000 increase this value to a population equivalent of 10,412,820.

Table B. Sources of pollution, industrial*

Industries	Sources of pollution (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	83	2,797,000
Producing organic wastes	297	Undetermined
Producing inorganic wastes	62	Not applicable
Producing wastes of undetermined type	1	Undetermined
Total	443	--

*Industries having separate outlets and discharging wastes directly to watercourse or land.

DAMAGES TO WATER RESOURCES FROM POLLUTION

Seasonal variations in the supply of water in these Basins, and the extreme geographic differences in the amount of this supply, necessitate conditions of water storage and transport that require special attention to safeguard health and protect economic values.

In the consideration of damages from water pollution in these Basins, it should be noted that ground waters are of paramount importance in California, and that damage to ground waters is of long-lasting nature, whereas surface waters recover rapidly when the sources of pollution are removed.

The principal types of damages that result from water pollution are health hazards from "contamination" of surface and underground waters by sewage and certain of the industrial wastes and economic damage including deterioration of property values and decline of recreational values.

It is beyond the scope of this report to present a detailed account of water pollution damage effects in the Basins; however, attention is called to a few specific damages that have occurred and to some of the potential damages and their significance.

In 1943, because of serious beach pollution in the vicinity of the sewage discharged from the City of Los Angeles sewerage system at Hyperion, approximately ten miles of beach area on Santa Monica Bay, estimated to be visited by 40 million people annually, was quarantined by the California State Board of Public Health. The direct and indirect losses resulting from closing of this recreational area would be difficult to evaluate. However, because of congestion of neighboring beaches, it was estimated that the people of the region would have to drive, collectively, 50 million additional miles per year for seashore recreation or forego this type of recreation. The direct loss on this single item of extra travel would exceed 1 million dollars per year. To remedy this situation the City of Los Angeles has constructed a complete treatment plant at a cost of over 40 million dollars. The damage to the beaches and loss of the recreational area, however, justified and brought about this remedial action.

At Pittsburgh, Calif., in 1920, use of a sewage-contaminated source of water supply and breakdown of treatment facilities (chlorination sole safeguard) resulted in 144 cases of typhoid fever and two deaths.

The waters of the Sacramento-San Joaquin Delta below Sacramento and Stockton receive large quantities of sewage and industrial wastes primarily from these two large population centers. Because of sewage treatment works provided at Stockton and the dilution available at Sacramento, bacterial contamination has been at a relatively low level. Similar pollution effects have occurred in the Tuolumne River at Modesto primarily due to the heavy summer load of cannery wastes. At Stockton, in 1948, approximately 6 1/2 miles of river channel was black and septic for a period of several weeks, while the sewage treatment plant was being bypassed during construction of new works. Gross pollution of the south end of San Francisco Bay has existed in recent years from discharge of the untreated wastes of the City of San Jose including heavy loads of cannery and other industrial wastes. It is significant to note that at all of these places, new waste treatment works or additions to existing works are planned or under construction, to overcome the damaging effects of pollution. Wastes from fish processing plants at Monterey and San Francisco Bays, and at San Pedro have resulted in fouling of tidal waters. In 1935 and 1936, pollution from winery wastes, primarily still slops, prevented upstream runs of salmon in the Mokelumne River.

As a result of the use of storm drains for industrial waste discharge and also due to the direct discharge of such wastes to the Los Angeles River, pollution conditions, public health hazards and nuisances occurred along the course of the river channel. In 1941, for example, such discharge of plating wastes by an aircraft manufacturing plant resulted in contaminating wells of the City of Los Angeles with hexavalent chromium. In 1941 and 1947, beach quarantines were necessary eastwardly from the mouth of the Los Angeles River. In the fall of 1947, because of increasing concern over pollution effects in the river, State, City and County officials met and agreed that a committee representing agencies with regulatory powers to control pollution should study the extent of pollution in the Los Angeles River and initiate a pollution abatement program. As a result of the Committee's activities all significant sources of pollution have been ascertained, many pollution situations have been remedied, and a continuing program of correction and control is underway. Activities of this Committee have been coordinated with those of the Regional Water Pollution Control Board, established in 1949.

Damages from another type of pollution -- salt water intrusion into underground aquifers of coastal basins by overdrafts from the basins--can be of great economic significance. Control of pollution of this nature wil require coordinated efforts by all State and local agencies concerned and by the individual users of the ground water resources of these basins.

Important recreational values of the Basins have suffered damage from pollution. In 1948, sewage disposal ponds near Woodland, serving as resting places for large numbers of waterfowl, were found to be the source of extensive waterfowl destruction. In 1947, losses of approximately 14,000 ducks and 1,500 coots were attributed to indirect contamination from these ponds. In the San Francisco Bay area ducks have been known to develop a sewer smell which is attributed to their feeding on sewage in waste disposal areas. Discharge of cannery wastes to the Tuolumne River coincides with the run of king salmon, Periodically, organic wastes from the canneries have caused an almost complete lack of dissolved oxygen throughout several miles of the river. This condition provides an effective block against the migration of one of the most important sport and commercial species. Also, high fish mortalities have resulted.

Damages to salt water plants and animals and definite nuisances to vacationists have resulted from the operation of numerous fish canning and reduction plants at San Pedro, Monterey and San Francisco. Occasionally, bilge containing about two percent suspended solids is still discharged to inshore waters. However, the principal pollution load from the fishing industry has been the waste, known as "stick water", that remains after removal of fish oil and meal in the reduction process. Some releases of stick water are still made to harbor waters with serious nuisance effects and with economic implications to nearby property owners. Analyses of stick water have shown that at one time pollution from this source on peak fishing days has placed an organic load on the receiving San Francisco Bay area waters equivalent to the wastes from a population of five million.

Tailings from gold placer mining and hydraulic mining have caused serious damage in the California Basins, especially in the Klamath and Trinity Rivers, where the practice of wasting tailings into the rivers is now outlawed during the period from July 1 to November 30.

Siltation in the numerous tributaries on the east side of the Central Valley has reduced the volume of the fisheries and produced undesirable changes on the aquatic habitat and in the economic value of adjacent shore areas. Spawning areas are known to suffer from resulting depositions of silt and from reduction of bottom fish food.

Renewal of mining operations in different parts of the Basins has necessitated the pumping out of old tunnel shafts. Shaft waters are often high in acid content and may contain metals that are injurious to fish life. The pumped material of one tunnel killed fish 60 miles downstream. Because of tunnel drainage above Shasta Dam, it was felt that copper contamination might prove destructive to fish in Shasta Reservoir, so efforts were made to seal off the tunnels. In Plumas County, drainage of untreated tunnel water from a copper mine caused serious damage to fish life and remedial action was required.

Although the damage has been greatly lessened, there are still instances of silting in the Sacramento and San Joaquin Rivers due to sand and gravel mining. The Russian River in the North Coastal Sub-Basin affords one illustration of this type of pollution destructive to aquatic life.

Damages to stream environments have resulted from dumping sawdust into the water and from releasing water from log holding ponds. This pollution hazard was accentuated during the war, because of the increase in number of sawmills.

Particularly in past years, effluents from industrial plants on the coast have caused heavy fish mortality and serious nuisances. In San Francisco Bay, both municipal and industrial pollutants have operated to seriously reduce the biological potential of the Bay waters and to practically exterminate the commercial shellfish industry that thrived earlier in this century. Reportedly, a million dollar oyster industry has been wiped out due entirely to water pollution.

BENEFITS RESULTING FROM POLLUTION PREVENTION AND ABATEMENT

It has been pointed out that water is actually the life blood of the California Basins, and that ultimately growth of the Basins will be dependent upon utilization of every drop of the annual water crop. Accordingly, the greatest benefit that will accrue from adequate pollution control measures is insuring the usability of all water resources for beneficial use insofar as quality is concerned. In fact, if the Basins' ultimate estimated water requirements are to be met, reuse of water will be essential. Any development for reuse, such as reclamation of waste waters for industrial or agricultural purposes or any step taken to provide water quality protection, can result in lasting economic advantage to the Basins.

The community sewage treatment plants which have been built over the past years and the treatment and proper disposal of industrial wastes that has been accomplished have been water conservation measures of utmost significance. These measures have kept the waters of the Basins from being polluted beyond recovery for beneficial use.

The dollar value of this water conservation benefit would not be easy to estimate, but there is no question that it would be a most sizable figure. The greatly accelerated rate of population growth of the Basins in the past decade, and its increasing industrialization require a vigilant continuance of pollution prevention activities to avoid any future retrogression in the position thus far attained with regard to quality of the Basins' water resources.

Specific mention of tangible benefits of past pollution prevention and abatement measures in the Basins will be of interest and some of these are mentioned here.

Lifting of the quarantine at portions of certain beaches in Los Angeles County has been made possible by the new Hyperion treatment plant. Swimming is now permitted in San Francisco's ocean beaches as a result of treatment of domestic wastes. The construction of tailings ponds in areas where hydraulic mining is permitted has reduced stream turbidity and restored natural fish habitats which were destroyed by the sediment. Restrictions on logging and sawmill operations have removed a threat to the fish and aquatic life of many California streams. In the past, the waters of Los Angeles harbor have seriously attacked the paint and hulls of craft moored there. This economic loss has been largely overcome by the construction of waste collection and treatment facilities.

In addition to benefits that have resulted from past pollution abatement activities, there are potential benefits to be expected from current construction activities. The foremost is the clean up of San Francisco Bay. Gross pollution now exists along the eastern shores of the Bay with accompanying nuisance and land depreciation. The current waste treatment construction program of the East Bay Cities is expected to remove the obnoxious odors and greatly increase property values along the Bay. New waste treatment plants under construction in San Francisco can also be expected to improve the quality of the Bay waters.

Pollution contributed to the passing of a once flourishing shellfish industry in Humboldt Bay. The four treatment plants now under construction for the population centers which discharge wastes to Humboldt Bay should reduce pollution so as to permit reestablishment there of the shellfish industry. Construction of additional waste treatment facilities at Stockton is expected to prevent yearly nuisances experienced during the cannery season.

Among benefits which may be realized from pollution control at some future date are: The reestablishment of the oyster industry once prominent in San Francisco Bay; the improvement of certain reaches of the Sacramento and San Joaquin Rivers to that higher water uses may be enjoyed; the improvement of the water of Monterey Bay which is currently so badly polluted by fish-processing wastes that packers find difficulty in using the bay water for washing and fluming.

Prominent among the less tangible but nevertheless real benefits which will result from pollution abatement is the improvement of public health environment. Potential health hazards arise from pollution and contamination of surface and underground waters which are used for domestic water supplies, for irrigation of crops grown for human consumption, and for bathing and recreational purposes. In these Basins most of the surface water supplies are diverted above large sources of pollution but downstream from recreational areas. Thus, proper watershed sanitation practices in recreational areas would be expected to improve raw water quality, thereby benefiting communities using surface waters.

POLLUTION PREVENTION MEASURES IN EFFECT

Table C indicates 438 of the 529 sewered communities in the California Basins have provided sewage treatment facilities for their wastes. Two hundred and forty-four of the communities, with a combined population of over 3,355,000, have provided 198 primary treatment plants. One hundred and ninety-four sewered communities with a combined population of about 3,024,000 have provided 167 secondary treatment plants. Ninety-one communities with a combined population of 2,043,700 or 24 percent of the sewered population of the Basins have no waste treatment facilities. Several of the Sub-basins have treatment facilities for all of their collected wastes. These are: Shasta Reservoir, Kings-Kern Rivers and Tulare Lake, Santa Clara River, Los Angeles River, and Santa Ana River Sub-Basins. Several others have provided treatment facilities for over 90 percent of their collected wastes. The latter are: the Klamath River and the San Diego Sub-Basins with 97 percent each, the San Joaquin River Sub-Basin with 94 percent, and the Santa Maria and Santa Ynez Rivers Sub-Basin with 93 percent. The Los Angeles River Sub-Basin leads in adequacy of its existing treatment facilities which are adequate for present loads. It is seconded by the San Diego Sub-Basin which has provided adequate sewage treatment facilities for 87 percent of its sewered population.

The data presented in this report represent the situation as of July 1, 1950. It should be noted that there are three large sewage treatment plants under construction in the San Francisco Bay Sub-Basin and upon their completion in 1951 over one million additional persons will be served by adequate treatment facilities.

Table D indicates that of the 443 industrial plants with separate discharges, 199 have provided waste treatment facilities. The pollution prevention measures that may have been adopted at 195 plants are undetermined and 49 are known to have no waste treatment facilities.

Map No. 2 shows the number of existing municipal and industrial waste treatment facilities for each of the Sub-basins in the California Basins.

Table E indicates that 232 of the 365 municipal waste treatment plants in the Basins based on present information are adequate as to design capacity and degree of treatment provided, 120 are inadequate, and the adequacy of 13 is undetermined. Operation of 249 of the municipal treatment plants is satisfactory, operation of 92 is unsatisfactory, and the adequacy of operation is undetermined for 24.

Thirty-eight of the industrial waste treatment plants are adequate as to design capacity and degree of treatment, 20 are inadequate and the adequacy of 141 is undetermined. Operation of 41 of the industrial waste treatment plants is satisfactory, 11 unsatisfactory, and 147 undetermined.

Progress in providing treatment works for municipal wastes in the California Basins has been very good in recent years as shown in table F. Much of the activity has been stimulated by State funds made available to communities on a matching basis for postwar construction of needed public works. Most of the new domestic sewage treatment plants of the last decade have been built since the end of World War II. During the four and one-half year period to July 1, 1950, 101 municipal plants were built to serve a population of approximately 5,870,000, and construction was started on three new treatment plants in the San Francisco Bay area to serve an additional population of approximately one million. While the construction represents very good progress in municipal pollution abatement in the Basins, it is partially offset by a population increase of over 4,500,000 for the ten year period from 1940 to 1950.

Some progress has also been made on adoption of pollution prevention measures by industries in the Basins, but available information is incomplete and additional studies are required to give the complete picture. Only 199 of the 443 industries with separate waste discharges are known to have treatment facilities, and little factual information is available as to the treatment facilities that have been constructed in recent years.

The following Federal and State financial aid measures are noted because of their significance as pollution prevention measures now in effect:

1. In California the 1946 "Construction and Employment Act" amended to extend to December 31, 1952, made $90 million available to cities and counties for construction of public works. Of the $45 million made available to cities, construction of sewage facilities is given first priority, and two-thirds of the $45 million made available to counties can also be drawn upon for construction of sewage facilities in which there is a State interest.

The 1949 Statutes of California (Chapter 1551) make further financial assistance available to communities for sewerage projects by means of loans from a $1 million State Water Pollution Control Fund administered by the State Water Pollution Control Board.

2. Section 8(a) of Public Law 845, 80th Congress, makes available to the States grants for conduct of investigations, research, surveys, and studies related to the control and prevention of water pollution caused by industrial wastes. For California this grant amounted to $27,370 in fiscal year 1950, and $28,400 in fiscal year 1951.

3. Public Law 352 has made funds available in the form of non-interest bearing loans to communities for planning waste treatment works as well as other public works.

Comprehensive changes in State laws for control of water pollution were enacted by the California Legislature at its 1949 Regular Session. These changes carry out recommendations of the Interim Fact-Finding Committee on Water Pollution. The Committee summarized the Legislation in part, as follows:

> "1. The existing permit law, which in theory requires that all disposals of sewage or industrial waste be controlled under permit issued by the State Department of Public Health, is repealed on December 15, 1949 (Chapter 1550). By this action the health officials are enabled to concentrate their effort upon those conditions which are, or threaten to become, actual hazards to the public health. The term 'contamination' is defined to mean . . . ' an impairment of the quality of the waters of the State by sewage or industrial waste to a degree which creates an actual hazard to the public health . . . '. State and local health officers both are empowered to issue peremptory orders for abatement of conditions of contamination, and any person failing to correct such a condition may be guilty of a misdemeanor.
>
> "Various sections are added to the Health and Safety Code to strengthen the powers of State and local health officers in control of individual sewage disposal, and the act also provides for adequate supervision and control of the hundreds of so-called small water systems which were unregulated under previous law.
>
> "2. Control of the economic effects of sewage and industrial waste is established by the Dickey Water Pollution Act (Chapter 1549). The terms 'pollution' and 'nuisance' are defined in the act to mean the adverse and unreasonable effects of disposal of sewage or industrial waste which are not actual hazards to health. Pollution and nuisance are subject to control by Regional Water Pollution Control Boards which are created for the nine major drainage regions of the State. The regional boards are composed of five appointees representative of the major interests involved. They have the duty to coordinate the action of the numerous governmental agencies involved and to promote cooperative action with waste producing industries. The boards are empowered to make and enforce rulings as to conditions to be maintained in all instances of pollution and nuisance, existing or threatened, within their region, but the boards may not specify the manner or means of maintaining the required conditions. Communities within a region are not prevented from adopting and enforcing additional regualtions which may be deemed necessary. Upon failure of anyone to comply with an order of a regional board, an action for injunctive relief must be brought by the district attorney, or, if he should fail to act, by the Attorney General.
>
> "A State Water Pollution Control Board is created, consisting of the State Engineer, the Directors of the Departments of Public Health, Agriculture, and Natural Resources, and nine appointees representative of the regions of the State and of the various interests in these problems. The State board has the duty to undertake State-wide planning for pollution control, acting in an advisory capacity to the regional boards. It will direct research programs in the technical phases of pollution control, and will administer the State Water Pollution Control Fund. The State board may act as an appeal board in any specific instance of pollution where it is found that a regional board has not taken proper action.
>
> "An executive officer and staff is provided for each of the boards. Funds for administrative expenses are appropriated to the State board for allocation to the regional boards (Chapter 1554). The State and regional boards may obtain assistance from any State or local agency, and the State agencies most concerned with pollution problems--the Department of Public Health, the Division of Fish and Game and the Division of Water Resources--are specifically directed to cooperate with and assist the controls boards (Chapters 1549, 1550, 1552, and 1553)."

Chapter 1552 of the 1949 Statutes directs the Division of Water Resources of the Department of Public Works to investigate conditions of the quality of all waters within the State as related to all sources of pollution of whatever nature and to conduct surveys and investigations relating to the reclamation of water from sewage or industrial wastes for beneficial purposes.

This administrative set-up in California is unique in the United States, and resulted from an intensive 2-year study of the California problem by the legislative committee mentioned previously.

In Oregon, administrative control over water pollution is vested in the Oregon State Sanitary Authority which is established in the State Board of Health. Comprehensive authority is centered in this single State agency. It has established an outstanding record of accomplishment and progress in conservation of the State's water resources during the 12-year period of its existence.

Table C.
Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	244	198	3,355,593
Secondary	194	167	3,023,856
No treatment	91	—	2,043,736

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

Table D. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Manufacturing industries:				
Food and kindred products	365	164	39	162
Lumber and wood products (except furniture).......	11	1	1	9
Paper and allied products	1	1	--	--
Chemical and allied products................	18	7	2	9
Products of petroleum or coal....................	6	5	--	1
Rubber products..........	2	1	--	1
Leather and leather products................	3	--	--	3
Primary metal industries	3	2	1	--
Fabricated metal products (except ordnance, machinery, and transportation equipment)	4	4	--	--
Miscellaneous	3	3	--	--
Nonmanufacturing industries:				
Oil production industry	12	8	4	--
Mine drainage............	6	--	--	6
Other mining industries	9	3	2	4
Total	443	199	49	195

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table E. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	365	232	120	13	249	92	24
Industrial	199	38	20	141	41	11	147

Table F. Progress in pollution abatement

Year	Municipal		Industrial*	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	9	55,250	—	—
1947	6	1,372,300	—	—
1948	12	242,700	—	10,000
1949	30	948,385	—	—
1950	44	3,250,514	—	—

*This portion of the table is incomplete due to lack of additional data on construction of industrial waste treatment works.

POLLUTION PREVENTION MEASURES REQUIRED

Requirements for treatment of municipal and industrial wastes in the Basins are summarized in table G and the status of projects to meet these requirements is indicated in table H.

Based on presently available information there are 142 new treatment plants needed in the Basins to serve a population of 2,385,700. A total of 84 of these plants are needed to serve communities that now have no treatment facilities and 58 are required to replace existing facilities that are obsolete. An additional 62 plants serving a population of 369,400 need enlargements or additions, and the requirements at 13 plants serving a population of 27,900 have not been determined. In comparison, 232 communities with a combined population of 5,640,200 or 67 percent of the total sewered population of 8,423,200 have provided waste treatment facilities that are considered to be satisfactory for present conditions.

Of these municipal projects 31 would serve communities with populations of 500 to 1,000; 72 would serve populations of 1,000 to 5,000; 28 would serve populations of 5,000 to 10,000; 34 would serve populations of 10,000 to 50,000, and 6 would serve populations of over 100,000.

Estimation of the cost of construction of needed community waste treatment facilities in the Basins is difficult since the cost of each project will depend upon the degree of treatment necessary to meet the requirements set up by the Regional Water Pollution Control Boards. In most cases the Regional Boards will need to secure, through public hearings and technical investigations, detailed information on present water conditions and uses of receiving bodies of water in order to prescribe requirements as to the nature of waste discharges. Under present conditions, per capita cost for the 2,385,700 population requiring new treatment facilities could vary from $10 to $60 depending upon the design capacity of the plant and the type of treatment provided. Per capita cost for the 369,400 population requiring enlargements or additions to existing plants and for the 27,900 population where project requirements are undetermined would no doubt be somewhat less than for the above figures for new plants depending upon the salvage value of existing facilities. It should also be remembered that per capita costs indicated above are for treatment facilities only and that cost of collection and outfall sewers required to deliver sewage to the treatment plant could in some instances approach the cost of treatment facilities.

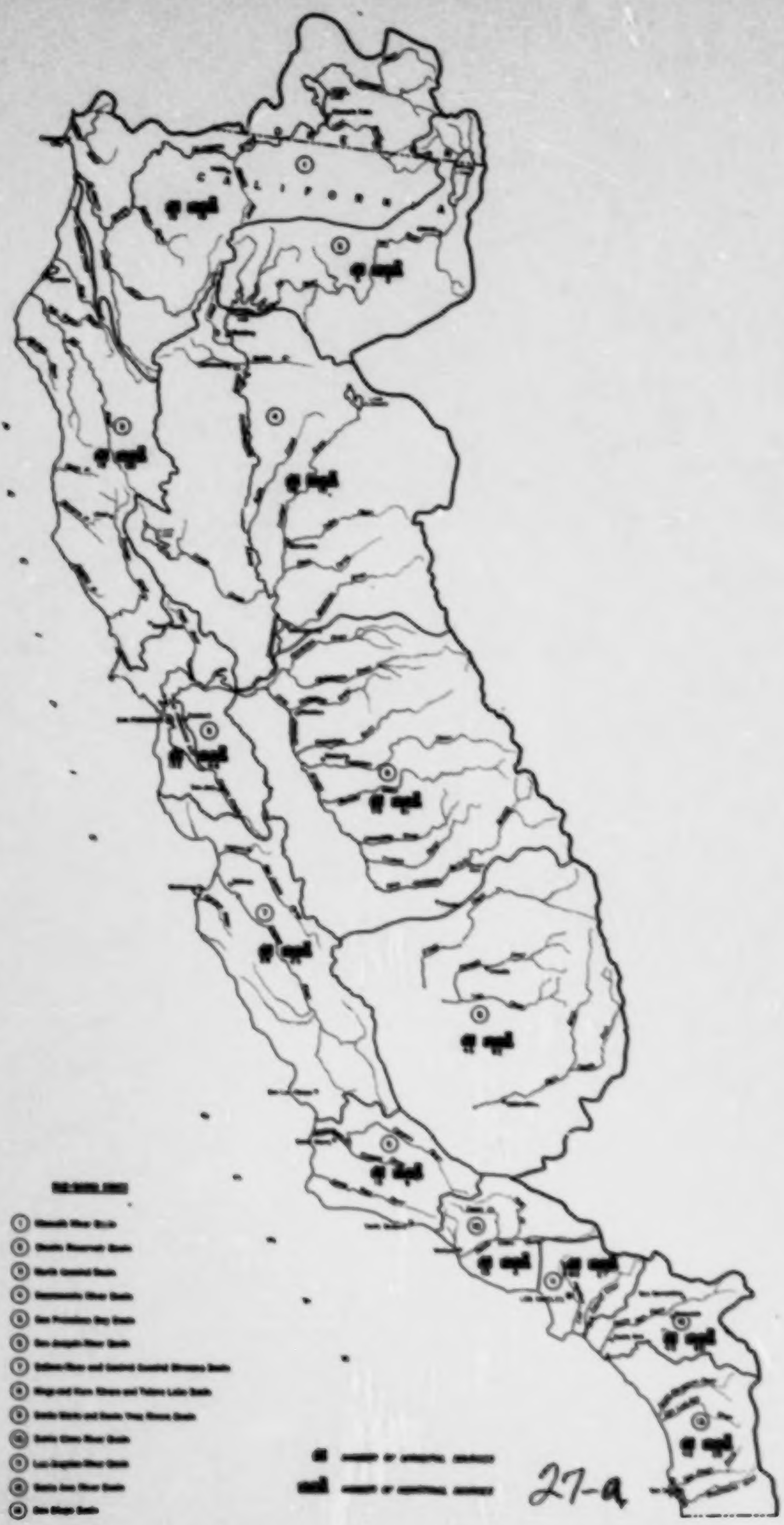
Of the 443 known industrial plants with separate waste discharges, nine require new waste treatment plants, six require enlargements or additions, one requires replacement, and 38 require no improvements. Requirements for waste treatment are undetermined at 389 of the 443 industrial plants in the Basins. Hence, at over 83 percent of the industries investigations are needed to determine the actual pollution prevention measures required. Most of the industries with existing industrial waste treatment plants are in sections of the Basins which are extremely water conscious and where, accordingly, disposal of industrial wastes has been closely regulated by local governmental authority.

In other sections of the Basins there has been less urgency for local regulation, because assimilation of wastes without serious impairment of water quality has been possible due to the more ample dilution waters available. Industries in these places have, therefore, been able to dispose of their wastes with little or no treatment.

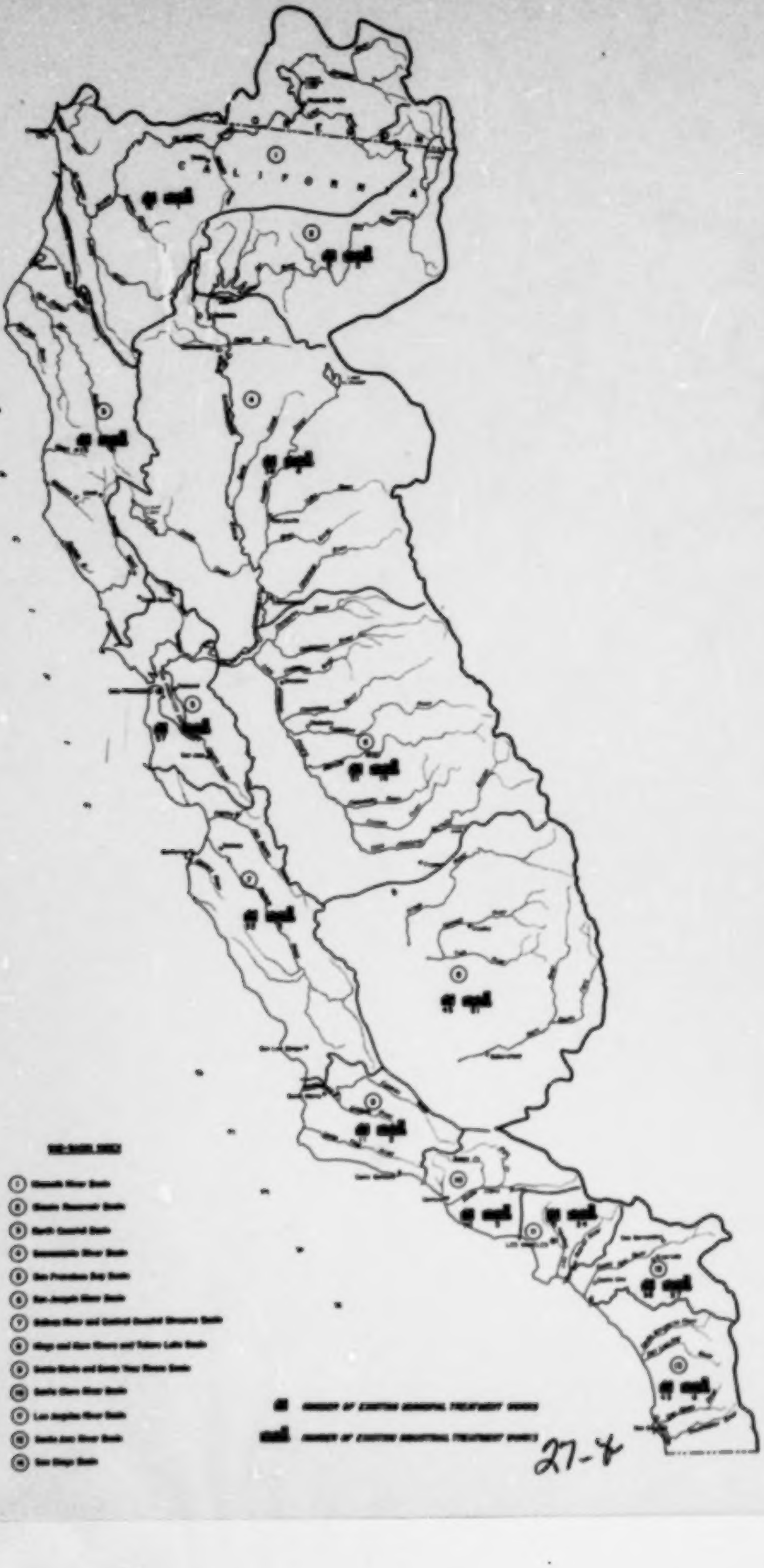
Estimation of the cost of needed industrial waste treatment facilities is impossible on the basis of presently available information. Before such an estimate can be made all industries with separate waste discharge must be identified, and additional information must be obtained in many cases on present water quality and indicated water uses in receiving bodies of water before requirements as to the nature of these waste discharges can be prescribed by the Regional Water Pollution Control Boards.

In table H is presented the currently available information on the status of projects to abate water pollution. At 151 municipalities some specific action is under way for provision of treatment works. At three other places abatement orders have been issued. No formal action has been undertaken at 46 places and no information is available on the status of 17 other places. With regard to industrial waste treatment, information is not available on 393 plants, abatement has been ordered at one plant, two plants have facilities under construction and final plans have been approved for nine plants.

The very rapid growth of many communities in the California Basins as shown by an increase of 52 percent in the Basins' population during the ten year period from 1940 to 1950


CALIFORNIA
Klamath River Basin
Shasta Reservoir Basin
North Coastal Basin
Sacramento River Basin
San Francisco Bay Basin
San Joaquin River Basin
Salinas River and Central Coastal Streams Basin
Kings and Kern Rivers and Tulare Lake Basin
Santa Maria and Santa Ynez Rivers Basin
Santa Clara River Basin
Los Angeles River Basin
Santa Ana River Basin
San Diego Basin
SCALE OF MILES

CALIFORNIA DRAINAGE BASINS
SOURCES OF POLLUTION
FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP No. 1


C A L I F O R N I A
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① Klamath River Basin
② Shasta Reservoir Basin
③ North Coastal Basin
④ Sacramento River Basin
⑤ San Francisco Bay Basin
⑥ San Joaquin River Basin
⑦ Salinas River and Central Coastal Streams Basin
⑧ Kings and Kern Rivers and Tulare Lake Basin
⑨ Santa Maria and Santa Ynez Rivers Basin
⑩ Santa Clara River Basin
⑪ Los Angeles River Basin
⑫ Santa Ana River Basin
⑬ San Diego Basin
NUMBER OF EXISTING MUNICIPAL TREATMENT WORKS
NUMBER OF EXISTING INDUSTRIAL TREATMENT WORKS
LOS ANGELES

27-8

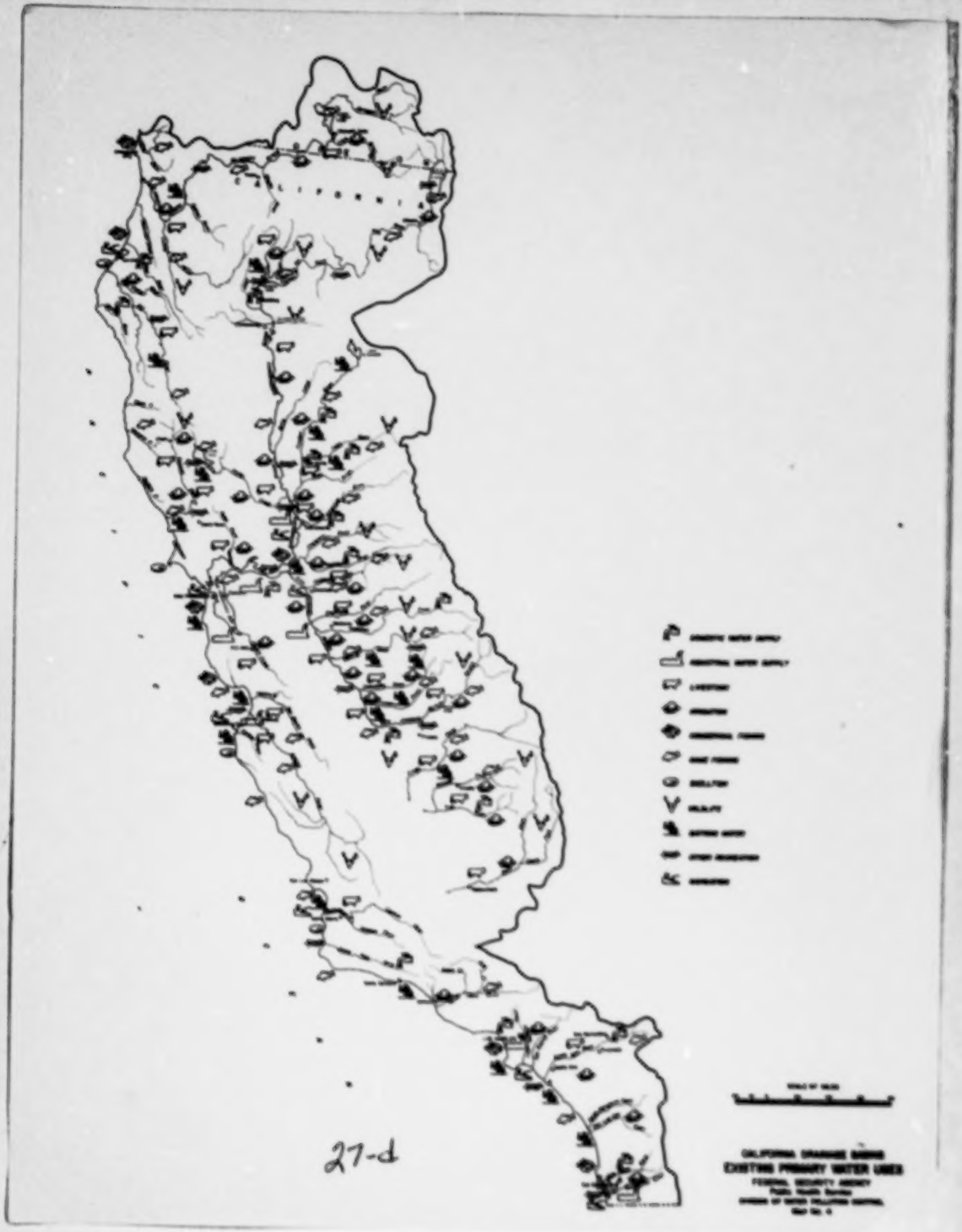
SCALE OF MILES

CALIFORNIA DRAINAGE BASINS
EXISTING TREATMENT WORKS
FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP No. 2

SCALE OF MILES
Klamath River Basin
North Coastal Basin
Sacramento River Basin
San Francisco Bay Basin
San Joaquin River Basin
Salinas River and Central Coastal Streams Basin
Kings and Kern Rivers and Tulare Lake Basin
Santa Maria and Santa Ynez Rivers Basin
Santa Clara River Basin
Los Angeles River Basin
Santa Ana River Basin
San Diego Basin

CALIFORNIA DRAINAGE BASINS
PROJECTS REQUIRED
FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
Map No. 2

27-C



CALIFORNIA DRAINAGE BASINS
EXISTING PRIMARY WATER USES
FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
Map No. 4

27-d

complicates the analysis of pollution prevention measures required. Although 232 of the 365 municipal waste treatment plants in the California Basins, or 64 percent, are considered satisfactory for present conditions, many of these plants are loaded to their designed capacity and will require enlargements or additions in the near future to take care of anticipated growth. In some areas growth has been so rapid that sewage flow to new collection and treatment facilities has reached or exceeded the design capacity by the time construction is completed. The increasing need for water for all uses coupled with increasing domestic and industrial waste discharges will require a continuous active planning and waste treatment construction program.

Map No. 3 entitled "Projects Required," shows the number of construction projects needed in each Sub-basin. The detailed statistical data concerning sources of pollution in each of the 13 Sub-basins are presented in Tables G_1 to G_{13} and H_1 to H_{13} in Part II of this report.

The San Francisco Bay Sub-basin with only 54 percent of the 132 municipalities and 26 percent of the sewered population of 2,420,700 served by treatment works is the area in the Basins where the least pollution control work has been done. Three new sewage treatment plants now under construction in the Bay area to serve a population of over a million will soon take care of the largest population centers, and it is believed the smaller communities will follow the lead of the larger ones in adopting pollution control measures.

The Sacramento River Sub-Basin with only 38 percent of the sewered population of 266,000 served by treatment works ranks next above the San Francisco Bay area in the amount of pollution control work accomplished. Actually 38 of the 46 communities in the Sub-basin have treatment works, but Sacramento, with no treatment for its population of 134,300 lowers the percentage from a population stand point. However, it should be noted that the Regional Water Pollution Control Board has recently prescribed requirements as to the nature of waste discharges that must be met by the City of Sacramento, and the city is proceeding with plans to construct the necessary facilities.

In addition to actual construction of waste treatment works to meet current needs, there are other requirements for a sound pollution abatement program in the California Basins. One of these is a comprehensive study of the industrial wastes produced in the Basins, their locations, amounts, strengths, damages, etc. A second is research into water quality requirements for specific uses. A third is the conduct of research and of pilot plant studies for industrial waste treatment, preferably by the industry concerned, to develop practical and economical methods of overcoming troublesome industrial waste disposal problems. A fourth is a continuing Basin-wide sampling and analytical program, to ascertain water quality in the Basins which will serve to show existing conditions and permit the evaluation of future improvement or deterioration in water quality.

Table G. Requirements for municipal and industrial waste treatment plants**

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	84*	2,044,036	9
Enlargement or additions to existing plant	62	389,403	6
Replace existing plant	58	341,635	1
No project required	232	5,640,179	38
Undetermined	13	27,900	389

*Of these plants, one will serve six sources; three will serve two sources each; two will serve one source.

**The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

Table H. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	46	--
Abatement ordered	3	1
Plans under preparation	121	--
Final plans approved	5	9
Construction awaiting financing	--	--
Under construction	25	2
Status undetermined	17	393

SUB-BASIN REPORTS

KLAMATH RIVER SUB-BASIN

Description and Economic Development

The Klamath River Sub-Basin, situated in the northwestern part of California and southwestern Oregon, comprises an area of 15,690 square miles, of which 4,540 square miles are in Oregon. The counties represented within this watershed are Del Norte, Humboldt, Modoc, Siskiyou and Trinity in California, and Curry, Jackson, Klamath and Lake Counties in Oregon. The western section of the sub-basin, located in California, includes the major watershed of the Klamath and Trinity Rivers. It is in the higher, mountainous part of the Coastal Range with elevations over 8,000 feet. The westward extension of the sub-basin forms a mountainous link with the higher Cascades that lie to the east.

The estimated 1950 population of the sub-basin is 79,740, of which approximately 52 percent live in Oregon. Since 1940, the growth in population has been around 12 percent until now the population density is five persons per square mile in the area. Being a rugged, heavily forested and mountainous country, urban areas are small, the largest towns being Klamath Falls (15,805), and Yreka (3,139).

Varied climatic conditions include mild winters and relatively cool summers along over 50 miles of Pacific Ocean shoreline to extreme low temperatures at the high altitudes of the Coast and Cascade Ranges. The normal annual temperature is around 52° F., the normal maximum for July being about 90° F.

The annual rainfall in the valley ranges from 12 to 37 inches, and is much greater in the mountains. At Klamath Falls, elevation 4,100 feet, the average annual precipitation is 12.81 inches, while at Monumental in northeastern Del Norte County, it is 109.43 inches.

The following National Forests cover the major part of the sub-basin: Klamath, Shasta, Rogue River, Trinity, Modoc and Fremont.

Water supply from heavy snowfall and rainfall is greater in this watershed than most areas of California. Irrigation needs are correspondingly small. In this region agricultural lands, first irrigated in 1882, were served by Clear Lake Reservoir in 1909. Since then, the Klamath project has developed its water supply is provided by the Klamath River with its nearby tributaries, and by the closed basin which consists of Clear Lake, in Modoc County, Tule Lake and the connecting Lost River, with surrounding minor bodies of water. The number of irrigated farms in this project area is around 1,100, the population 37,191 and the principal crops are potatoes, grain, alfalfa, small seeds, vegetables, and pasture.

Expectedly, business activity in the sub-basin is small. The number of business establishments in 1947 in Del Norte County was 29 (698 employees), this being the average number for the four California counties represented in this watershed area. Retail sales in 1947 for these counties amounted to over 50 million dollars while the corresponding estimated cash farm income was over six million dollars. The total income of civilian residents of these four California counties in 1947 was approximately 77 million dollars. Agricultural lands are restricted to the valleys and rolling hills used for pasturage. Agricultural activity centers on raising livestock and growing wheat, rye, oats and hay. Siskiyou is the largest county in the sub-basin. Greatest farm income comes from beef, followed by dairy products, and then hogs. Much of the watershed is in a transition period, changing from the economy of the gold rush era to a planned and steady income economy aimed at a higher standard of rural living.

Principal mining activity is for gold. In the past, great damage to stream life resulted and now a California State law prohibits mining operations in the Trinity and Klamath River Fish and Game District between July 1st and November 30th "except where the debris, substances, tailings or other effluent from such operations cannot and do not pass into the waters in said district." In other parts of the sub-basin, pumice stone, silver, copper, sand and gravel, as well as gold, are mined in small quantities. Because of the great recreational importance of this watershed, California exercises special precaution to preserve the quality of the waters throughout the area. Placer and hydraulic mining is still a serious siltation threat to the rivers and streams. The disposal of mine tailings likewise presents a pollution problem. As a control measure the use of settling ponds is encouraged. A second threat to streams in the northern part of California rests in the disposal of saw-mill waste, mill pond effluent and sawdust. In 1948, the approximate number of sawmills was 73 and the total lumber sawed, 569 million board feet.

A major source of income to the sub-basin is recreation. On a basis of deer tag census records for 1948, over 6,000 deer were taken in Modoc, Shasta and Trinity Counties. The intensity of trout fishing is indicated by the 1948 catch of almost 1.5 million fish in Trinity and Siskiyou Counties alone. Reportedly, it is not uncommon for 100,000 people to fish on the Klamath River during a single season. Game, fish, and beautiful mountain scenery unite to make this a primary recreational center of the West.

Summary of Water Pollution Data

There are a total of 15 sewered communities in the sub-basin that may be considered as significant sources of pollution. Seven of the communities with a combined population of 23,050 are located in Oregon and discharge wastes with a population equivalent of 14,530 to surface waters. Seven communities with a population of 15,740 are located in California and discharge wastes with a population equivalent of 8,095 to surface waters. One additional California community with a population of 2,000 discharges wastes with a population equivalent of 1,300 to land where pollution of surface waters is not a problem.

There are also 15 known industries in the California portion of the sub-basin and one in the Oregon portion producing organic wastes, and 3 industries in the California portion of the sub-basin producing inorganic wastes which may be significant sources of pollution.

Fourteen of the 15 sewered communities have provided sewage treatment facilities for their wastes. Five of these communities with a population of 8,875 in California and three communities with a population of 20,300 in Oregon have provided primary treatment for their wastes, and two communities in California with a population of 7,500 and four communities in Oregon with a population of 2,750 have provided secondary treatment. One community in Oregon has provided secondary treatment. One community in Oregon has provided two primary treatment plants and one community in California has no waste treatment facilities.

The one known industry in Oregon has provided waste treatment, but the pollution prevention measures adopted by the 18 California industries in the sub-basin have not been determined.

Three of the seven municipal treatment plants in California and six of the eight plants in Oregon are considered to be satisfactory as to capacity and degree of treatment provided for present conditions. Four of the treatment plants in California and two plants in Oregon are considered to be inadequate as to capacity or degree of treatment provided. Operation of seven of the plants in Oregon and two in California is considered to be satisfactory; operation of one plant in Oregon and four in California is considered to be unsatisfactory; and the adequacy of operation of one plant in California has not been determined.

The information available on industrial waste treatment measures is not sufficient to permit determining the adequacy of the one known treatment plant or the needs for additional pollution prevention measures.

The requirements for municipal waste treatment facilities in the sub-basin are: One new treatment plant in California for a community with population of 1,365 which now has no treatment facilities, enlargements or additions for two plants in Oregon serving a population of 15,600, and four new plants in California to replace obsolete treatment facilities serving a population of 11,415. Six treatment plants in Oregon and three plants in California serving a combined population of 12,410 are satisfactory for present conditions.

Good progress has been made on pollution abatement in the sub-basin in recent years. One new plant was completed in Oregon in 1946 to serve a population of 4,000; one new plant was completed and one plant rebuilt in Oregon in 1947 to serve a combined population of 1,300; one new plant was completed in California and one in Oregon in 1949 to serve a combined population of 2,650; and one plant is under construction in California in 1950 to serve a population of 2,000. Two of the five communities needing new or improved waste treatment facilities in California have taken no formal action toward construction and three have plans under preparation. The two communities in Oregon requiring improved facilities have taken no formal action toward provision of the needed facilities. One community in California where present treatment facilities have been designated as satisfactory for present conditions also has plans for improved facilities.

The information available on the pollution prevention measures required by industries is not adequate to permit estimation of the industrial need. The area has had little industrial development other than lumbering and mining, and it is believed that most of the lumber mills and mines have adopted some pollution prevention measures, although the adequacy of such measures has not been determined.

The water resources of the Klamath River Sub-Basin as well as the North Coastal Sub-Basin remain largely undeveloped since normal stream flows have been adequate for most water uses. It is estimated that 41 percent of the water supply in the State of California occurs in the Klamath River and North Coastal Sub-Basins, which embrace only 12 percent of the total State area and need only 2 percent of the State's ultimate water requirements. Any proposed projects for storage and export of water from the sub-basin should be carefully studied as any change in the low flow condition of the stream will affect the water use within the sub-basin. Present stream conditions are believed to be satisfactory for all indicated uses except for the effect of inadequately treated sewage and industrial wastes on limited stretches of several streams.

Table A_1. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	"To watercourse"*** 14 "To land"*** 1	38,790 2,000	22,625 1,300
Having population data available (Data on pollution load to watercourse incomplete or not available)	—	—	Not applicable
Total	15	40,790	—

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, town; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

***In the arid west sewage collection and treatment systems discharge not only to watercourses where pollution of surface waters may be a problem but also to land where pollution of underground waters may occur. Accordingly, sources of pollution are broken down into these categories and listed as such in this table.

Table B_1. Sources of pollution, industrial*

Industries	Sources of pollution (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	—	—
Producing organic wastes	16	Undetermined
Producing inorganic wastes	3	Not applicable
Producing wastes of undetermined type	—	Undetermined
Total	19	—

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table C_1.
Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	8	9	29,175
Secondary	6	6	10,250
No treatment	1	—	1,365

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

Table D_1. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Manufacturing industries:				
Food and kindred products	6	1	--	5
Lumber and wood products (except furniture)	9	--	--	9
Nonmanufacturing industries:				
Mine drainage	4	--	--	4

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table E_1. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	15	9	6	0	9	5	1
Industrial	1	--	--	1	--	--	1

Table F_1. Progress in pollution abatement

Year	Municipal		Industrial*	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	1	4,000	--	--
1947	2	1,300	--	--
1948	--	--	--	--
1949	2	2,650	--	--
1950	1	2,000	--	--

*There is such a small amount of data available on industries at the present time that it is impossible to complete this section of the table.

Table G_1. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	1	1,365	--
Enlargement or additions to existing plant	2	15,600	--
Replace existing plant	4	11,415	--
No project required	9	12,410	--
Undetermined	0	--	19

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

Table H_1. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	4	--
Abatement ordered	--	--
Plans under preparation	3	--
Final plans approved	--	--
Construction awaiting financing	--	--
Under construction	--	--
Status undetermined	--	19

SHASTA RESERVOIR SUB-BASIN

Description and Economic Development

The Shasta Reservoir Sub-Basin comprises an area of 7,620 square miles. A northern portion of the area, occupying 8.5 percent of the sub-basin, is in Lake County, Oregon, while the remainder lies in Lassen, Modoc, Shasta, and Siskiyou Counties of California.

Principal bodies of water in the sub-basin are: (1) Shasta Lake in the southwest corner with the upper strength of the Sacramento River, the McCloud River and the Pit River extending in north and northeast directions through a heavily forested, sparsely populated, mountainous country; and (2) Goose Lake in the northeast corner of the sub-basin.

Most of the sub-basin is composed of parts of the Lassen, Modoc, and Shasta National Forests which constitute a rectangular timbered watershed traversed by two mountain ranges, the Cascades and the Pit Valley. The mountain ridges vary commonly from 4,000 to 7,000 feet in height while peaks may rise to 14,000 feet. These elevations divide the area into three natural topographic units: the lower Pit River drainage area comprising the Little Sacramento River and McCloud River, Squaw Creek and other minor tributaries; the middle Pit River area represented principally by Hat Creek and Fall River; and the upper Pit River watershed embracing the Pit River proper.

The Goose Lake watershed is separated from the main drainage by a low divide that makes it almost a separate watershed unit. Water has not overflowed this divide into the Pit River since 1898.

The first white settlements on the Pit River were made about 1865. Since then cattle and sheep raising have been the major industries with a progressive trend toward general farming. As early as 1900, general range depletion resulting from over-grazing was recognized.

The 1950 population of the sub-basin is estimated to be 32,700, the increase since 1940 being approximately 14 percent. About 17 percent of the people live in the Goose Lake drainage area. The number of people per square mile in the sub-basin is 4.3 and the principal towns are Dunsmuir, Mt. Shasta, McCloud, Alturas and Lakeview (Oregon), their individual populations being below 3,000.

The U. S. Forest Service has indicated that in 1935 only about 37 percent of the area was privately owned at which time around 55 percent of the crop land harvested was under irrigation and located chiefly in the valley bottoms. Approximately 50 percent of the sub-basin land is in pine and pine-fir forest used mainly for lumbering and under national ownership. Due to fires, much cover type has changed from timber to brush and erosion has become a serious problem with the result that there are four organized soil conservation districts in the area.

Average annual precipitation varies from 65 inches at Delta on the Sacramento River to ten inches in the plateau region west of Goose Lake. Most of the rainfall occurs from November through April. Snowfall is heaviest in the Little Sacramento Valley where an average annual fall of 106 inches occurs at the town of Mt. Shasta.

From 50 to 70 percent of the run-off from the Sacramento, McCloud and Pit Rivers occurs in the four months from January through April. The average annual discharge of the Sacramento River at Kennett for an eleven-year period before Shasta Dam was erected was 4,100,000 acre-feet.

Recreational uses of the sub-basin are important as indicated by nearly 1.5 million visitors to the Lassen, Modoc and Shasta National Forests in 1949. In the three California counties of the sub-basin, over one million trout were caught by 29,000 anglers in 1948, and the deer tag census indicated that over 6,000 deer were taken.

Mining operations in the counties represented in the sub-basin, principally for iron pyrite, zinc, gold, copper, sand and gravel, lead and stone, yielded a production valued at between two and three million dollars in 1947. The spent ore from milling operations has affected stream life in valuable tributary waters of the sub-basin. Vigilance on the part of State officials is also required to reduce pollution by lumbering operations. In 1948, there were an estimated 53 sawmills in the sub-basin, and the total lumber sawed was about 367 million board feet. During the past decade constructive steps have been taken in the State to protect the valuable fishing areas of the sub-basin against pollution.

Summary of Water Pollution Data

There are five sources of municipal waste pollution in the sub-basin. One of these communities with a population of 2,500 is located in Oregon and discharges wastes with a population equivalent of 500 to Thomas Creek and Goose Lake. Four of the communities with a combined population of 9,400 are located in California and discharge wastes with

a population equivalent of 640 to surface waters, and with a population equivalent of 2,400 to percolation beds.

There are two known industries that dispose of wastes by land disposal methods. The majority of communities in the sub-basin have mining and sawmill operations, but the amount of pollution discharged to watercourses has not been determined. There are also some dairies and small slaughterhouses for which no information is available. Domestic wastes are also discharged to Shasta Lake Reservoir from an estimated 200 excursion boats with toilet facilities and possibly from resort areas.

The five sewered communities have all been provided with secondary treatment plants. At two of the plants, standard rate trickling filters are used for secondary treatment, and at the other three plants the primary effluent is disposed of to oxidation ponds or percolation beds. The two known industries in the sub-basin also have provided treatment.

Two of the municipal treatment plants serving a population of 5,000 in California are satisfactory and require no project. The one treatment plant in Oregon and two of the plants in California serving a combined population of 6,900, require enlargement or additions. The one community in Oregon requiring improvements has plans under preparation.

One partially sewered community and eight unsewered communities in the sub-basin, while not now considered to be significant sources of pollution, may require construction of waste treatment facilities when sewage collection systems are provided.

The principal feature of the Shasta Reservoir Sub-Basin is the recently completed Shasta Dam which is the second largest concrete dam in the world and creates a reservoir with storage capacity of 4,500,000 acre-feet. Water released from Shasta Dam to the Sacramento River Sub-Basin will improve navigation in the Sacramento River, prevent salinity encroachment in the Sacramento-San Joaquin Delta, provide water for irrigation of lands in the Sacramento River Sub-Basin, and develop power for industries. Water from the Sacramento River will also be pumped from the Delta to the Contra Costa and Delta-Mendota Canals for irrigation of lands in the San Joaquin River Sub-Basin.

Due to the relatively high annual rainfall and lack of suitable land for irrigation in the Shasta Reservoir Sub-Basin, most of the run-off from the Shasta Reservoir Sub-basin (eleven year average, 4,100,000 acre-feet before construction of the Shasta Dam) is exported to the Sacramento River and to the San Joaquin River Sub-Basins. None of the few communities in the sub-basin use surface streams for public water supplies and industrial and irrigation use is not large. Recreational use of the Shasta Reservoir and tributary streams is very important.

Water quality throughout the sub-basin is satisfactory, except for a few short stretches of small streams receiving inadequately treated domestic waste or drainage from abandoned copper mines.

Table A_2. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	"Water" *** 3	7,900	1,140
	"Land" *** 2	4,000	2,400
Having population data available (Data on pollution load to watercourse incomplete or not available)	--	--	Not applicable
Total	5	11,900	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

***In the arid west sewage collection and treatment systems discharge not only to watercourses where pollution of surface waters may be a problem but also to land where pollution of underground waters may occur. Accordingly, sources of pollution are broken down into these categories and listed as such in this table.

Table B_2. Sources of pollution, industrial*

Industries	Sources of pollution (in number of plants) **	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	--	--
Producing organic wastes	2 (to land only)	Undetermined
Producing inorganic wastes	--	Not applicable
Producing wastes of undetermined type	--	Undetermined
Total	2	--

*Industries having separate outlets and discharging wastes directly to watercourse or land.

**There are many relatively small industries in this sub-basin not included in this table.

Table C_2.
Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	--	--	--
Secondary	5	5	11,900
No treatment	--	--	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

Table D_2. Existing treatment facilities, industrial*

Type industry	Number of plants**	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Manufacturing industries: Food and kindred products................	2	2	--	--

*Industries having separate outlets and discharging wastes directly to watercourse or land.

**There are many relatively small industries in this sub-basin not included on this table.

Table E_2. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	5	2	3	--	4	1	--
Industrial	2	2	--	--	--	--	2

Table F_2. Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	—	—	—	—
1947	—	—	—	—
1948	—	—	—	—
1949	—	—	—	—
1950	—	—	—	—

*There is such a small amount of data available on industries at the present time that it is impossible to complete this table.

Table G_2. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	0	—	—
Enlargement or additions to existing plant	3	6,900	—
Replace existing plant	0	—	—
No project required	2	5,000	2
Undetermined	—	—	—

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

Table H_2. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	2	—
Abatement ordered	—	—
Plans under preparation	1	—
Final plans approved	—	—
Construction awaiting financing	—	—
Under construction	—	—
Status undetermined	—	—

NORTH COASTAL SUB-BASIN

Description and Economic Development

The North Coastal Sub-Basin comprises an area of over 8,680 square miles, extending for about 280 miles along the Northern California coast between the San Francisco Bay area and Klamath River. This coastwise and mountainous area includes all of Mendocino County, 83 percent of Sonoma County, 22 percent of Marin County, 20 percent of Trinity County and 15 percent of Glenn County. Principal rivers within the Sub-basin include the Russian, Eel, Mad and Van Duzen. The Russian River, about 110 miles in length, drains a watershed in the Coastal Range that is about 80 miles long and from 10 to 30 miles wide, with an area of about 1,485 square miles. The drainage basin of the Eel River, 160 miles long, is about 3,675 square miles in area.

In general, elevation increases from west to east in the sub-basin and the eastern ridge line forming the divide between the coastal region and the Central Valley ranges from 3,000 to 7,000 feet in elevation. The largest body of fresh water is Lake Pillsbury, a man-made reservoir. With the exception of about 500 square miles of farmland, the sub-basin is covered by natural forests and extensive growth of manzanita and chaparral. The coast is rugged and precipitous, the only two protected bays of importance for transportation and recreation being Humboldt Bay in the north and Tomales Bay at the southern boundary of the sub-basin.

The climate of the coastal area is cool and moist, tempered by the Pacific Ocean, and with a difference between mean high and mean low temperatures of less than 10°F. The mean yearly temperature at Humboldt Bay is 51°F. Temperature and humidity conditions in the fertile river valleys are intermediate between those of the coast and the Central Valley. Growing seasons range from 173 days at the headwaters of the Eel River to 334 days near the mouth of the river. Precipitation is typically seasonal and increases with altitude and latitude. The best agricultural areas receive between 35 and 40 inches per year, mostly in winter. Snowfall is of short duration. Stream flows vary greatly. Underground storage of water is slight and the smaller streams go dry in summer. With future growth in population this condition may have waste disposal and recreational implications of primary importance to the area.

The population of the sub-basin is estimated to be approximately 180,900 in 1950, an increase of about 32 percent from 1940. Approximately one-third of the people live in the five largest cities, namely, Eureka (22,926), Santa Rosa (17,905), Petaluma (10,390), Ukiah (6,134) and Fort Bragg (3,808). Also, most of the population is concentrated in the lower valleys of the main drainage basins, espcially in the Russian River and Humboldt Bay areas.

The land area of the sub-basin is utilized as follows: 7.8 percent cultivated or devoted to urban or industrial use, 23.6 percent grass or grazing woodland, 57.4 percent in timber and 11.2 percent chaparral, sagebrush marsh or barren land. Major agricultural production includes fruit, notably grapes, and truck crops in the river valleys. Stock raising and dairying are also important. A total of only about 17,000 acres of land was irrigated in 1944 in Sonoma and Mendocino Counties, almost all in the Russian River area. Elsewhere, there is little irrigation due to high rainfall.

The major industries in 1948 included 71 wineries, 24 fruit and vetetable processing plants, 24 milk handling and processing plants, 6 fish processing plants, and about 320 lumber mills. Lumbering is the principal industry in Humboldt and Mendocino Counties. In 1948, the estimated production in the sub-basin was approximately 1.26 million board feet. The principal timber-producing trees being redwood, Douglas fir, white fir, and ponderosa pine.

The marine commercial fisheries of the coast constitute an important industry, the fish processing plants being centered mainly around Humboldt Bay. The principal fish are sole, salmon, rockfish, Pacific herring and shark, representing in 1947 over 21 million pounds of a total of almost 24 million pounds for the area. There is also a 5 million pound crab fishery. The only whaling station in continental United States is at Fields Landing near Eureka.

Recreation is a major industry of the sub-basin because of the extensive mountains and wooded areas with clear, cold streams, well supplied with sport fish. Principal catches include steelhead trout, king salmon and silver salmon. Including the famous "Redwood Empire," this area is one of the principal recreation and vacation lands in Northern California. Records of the California State Division of Fish and Game indicate that over 100,000 hunters and fishermen, alone, visited the sub-basin in 1948. Vacation resorts are especially numerous in the lower portion of the Russian River.

Summary of Water Pollution Data

There are 19 sewered communities in the sub-basin. Twelve communities with a combined population of 29,200 discharge organic wastes with a population equivalent of 23,600 to surface streams, two communities with a population of 10,700 discharge wastes with a population equivalent of 4,500 to land and five communities with a population of 29,700 discharge wastes with a population equivalent of 29,900 to the Pacific Ocean or tidal salt water. The total population served by sewerage systems is 69,600 or approximately 38 percent of the total 1950 population of 180,900 in the sub-basin. There are four additional communities with a combined population of 2,610 that are partially sewered and 12 smaller unsewered communities that may become significant sources of pollution when public sewer systems are provided.

The pollutional load contributed to the water resources of the sub-basin is increased in many instances by industrial wastes discharged to municipal sewer systems or discharged direct through private sewers. There are 65 known industries with separate waste discharges about which some information is available but not enough to permit determination of the population equivalent of industrial wastes discharged.

Thirteen of the 19 sewered communities in the sub-basin have provided treatment facilities for their wastes. Six of the 13 with a combined population of 21,900 have provided six primary treatment plants, while the remaining seven communities with a combined population of 19,700 have provided secondary treatment plants. Six communities with a combined population of 28,000 have no treatment facilities and discharge raw sewage to the water courses.

Many of the industries have provided waste treatment, usually some type of land disposal, but information concerning the individual plants is not complete.

Eight of the 13 municipal sewage treatment plants are considered to be adequate as to design capacity and degree of treatment provided, and the remaining five plants are considered to be unsatisfactory. Operation of all of the plants is satisfactory. There is not enough information available regarding the industrial waste treatment facilities to permit judging the adequacy of the facilities.

Progress has been made during the postwar years on pollution abatement in the sub-basin. Five communities with a combined population of 9,900 constructed and placed in operation new sewage treatment facilities during 1949 and the first six months of 1950.

Eleven of the communities in the sub-basin need new or improved treatment facilities. Eight of the 11 have plans under preparation for the required facilities and the remaining three have taken no formal action toward construction. The information available on required industrial waste treatment facilities is incomplete, and a great deal of additional information will be required before an estimate can be made of the pollution prevention measures required by industries.

The water resources of the sub-basin remain largely undeveloped as normal stream flows have been adequate for most water uses. It is estimated that 41 percent of the water supply in the State of California occurs in the North Coastal area, including the Klamath River, representing only 12 percent of the total area and needing only two percent of the State's ultimate water requirements. Any proposed projects for storage and export of water from the sub-basin should be carefully studied as any change in the low flow condition of the streams in the sub-basin will affect the water use within the sub-basin. Present water quality is believed to be satisfactory for all indicated water uses, except for the effect of inadequately treated sewage and industrial wastes on limited stretches of several streams. Studies are now being made by the Regional Water Pollution Control Board in cooperation with other State agencies to determine effect of the concentrated recreational use of the lower Russian River on water quality, but results of the studies are not yet available.

The location of the sub-basin near the large San Francisco Bay population center assures a continuous market for agriculture products and an increase in industrial and recreational development. Preservation of the recreational values of the area and the insurance of acceptable water supplies for future population growth and industrial expansion require a vigilant program of water pollution control.

Table A_3. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	"To watercourse" *** 12	29,175	23,620
	"To land" *** 2	10,700	4,500
	"To ocean" *** 5	29,700	29,900
Having population data available (Data on pollution load to watercourse incomplete or not available)	--	--	Not applicable
Total	19	69,575	--

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

***In the California Basins sewage collection and treatment systems discharge not only to watercourses where pollution of surface waters may be a problem but also to land where pollution of underground waters may occur and to the ocean where adequate dilution simplifies disposal. Accordingly, the sources of pollution are broken down into these three categories and listed as such in this table.

Table B_3. Sources of pollution, industrial*

Industries	Sources of pollution (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	--	--
Producing organic wastes	65	Undetermined
Producing inorganic wastes	--	Not applicable
Producing wastes of undetermined type	--	Undetermined
Total	65	--

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table C_3.
Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	6	6	21,875
Secondary	7	7	19,700
No treatment	6	0	28,000

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

Table D_3. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Manufacturing industries: Food and kindred products....................	65	--	--	65

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table E_3. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	13	8	5	0	13	0	0
Industrial*	—	—	—	—	—	—	—

*There is no information available on the 65 industries known to be discharging wastes directly to watercourses or land.

Table F_3. Progress in pollution abatement

Year	Municipal		Industrial*	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	—	—	—	—
1947	—	—	—	—
1948	—	—	—	—
1949	—	—	—	—
1950	5	9,900	—	—

*There is such a small amount of data available on industries at the present time that it is impossible to complete this section of the table.

Table G_3. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	6	28,000	—
Enlargement or additions to existing plant	2	3,000	—
Replace existing plant	3	16,375	—
No project required	8	22,200	—
Undetermined	0	—	65

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

Table H_3. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	3	—
Abatement ordered	—	—
Plans under preparation	8	—
Final plans approved	—	—
Construction awaiting financing	—	—
Under construction	—	—
Status undetermined	—	65

SACRAMENTO RIVER SUB-BASIN

Description and Economic Development

The Sacramento River Sub-Basin, ~~situated~~, in the Central Valley of California, comprises an area of 20,040 square miles. It includes all of Butte, Plumas, Sutter, Tehama, Yolo and Yuba counties and parts of Alpine, El Dorado, Glenn, Lake, Lassen, Napa, Nevada, Placer, Sacramento, Shasta, Sierra and Solano counties.

The Sacramento River extends approximately 310 miles in a north-south direction through the central portion of the watershed, between the precipitous Sierra Nevada and the Coast Range mountains. The principal tributaries of the Sacramento River include Clear, Cottonwood, Stony, Putah and Cache creeks entering from the west and American River, Feather River, Butte Creek, Pine Creek and Battle Creek originating in the eastern Sierra watershed. The fertile alluvial valley extends as far upstream as Red Bluff (about 200 miles) and includes approximately 2,447,000 acres of irrigable land. During low water periods tidal effect is felt on the River 80 miles upstream at the mouth of the Feather River. Below Sacramento, there is a 10-foot channel at low water having a minimum width of 150 feet.

The climate of the sub-basin is characterized by rainy winters and dry summers. In the valley floor rainfall is light, the average annual precipitation ranging from about 16 to 25 inches as compared to 80 or more inches in parts of the western slope of the Sierra between the 3,500 and 6,500-foot levels. The high Sierra Nevada Mountains approximate maximum U. S. snowfall, the great winter accumulation of snow provides a most important and economically valuable and constant source of water for cities, hydroelectric plants and irrigation purposes. Of great economic importance is the occasional, strong, north wind that blows down the valley from the high northern plateau with its desiccating effects on the agricultural lands of the interior valley floor.

Principal run-off comes from the Sierra Nevada Mountains and occurs from December until March. To regulate and control run-off, eight principal reservoirs are projected having a gross capacity of around six million acre-feet. The completed Shasta reservoir has a gross capacity of 4,500,000 acre-feet. The average annual run-off in the Central Valley is 33,000,000 acre-feet of which an estimated 25 million acre-feet originate in the drainage area of the Sacramento River and Shasta Reservoir Sub-Basins. In the valley at Red Bluff, the average annual temperature is 62.3° F., the average maximum temperature 73.8° F., and the average minimum temperature 50.8° F.

The estimated 1950 population of the sub-basin is slightly more than 622,000, an increase of 47 percent over 1940. Approximately 28 percent of the population live in the principal cities: namely, Sacramento (134,313), Chico (12,210), Redding (10,136), Roseville (8,685), and Marsville (7,777).

The valley floor trade area is primarily an agricultural region based upon irrigation. The main activities are agriculture and the processing of farm products, stock raising, manufacturing and mining. The principal farm crops are vegetables, fruit, nuts, rice, grain, sugar beets and forage. About one-third of all farms in the Central Valley (the lands of which, in 1939, represented approximately one-half of the State's agriculture) receive their major income from the production of fruits and nuts. In the Sacramento Valley this income is less than in the San Joaquin Valley, but in regard to dairy and livestock production the comparative relation is reversed. In respect to crops and livestock, the pattern in the Sacramento and San Joaquin Valleys is a close replica of that for the State. Figures for 1939 show that 37 percent of the total number of sheep and 22 percent of the number of hogs in the State were in the Sacramento Valley.

Approximately one-fourth of the people in the sub-basin live on farms and a large part of the remaining three-fourths depend on irrigated agriculture for a livelihood. According to the Bureau of Reclamation more than 90 percent of the gross farm income of the entire Central Valley is from irrigated crops.

Irrigation waters in the Sacramento Valley Sub-Basin are derived mainly from surface supplies. Most of the irrigated lands receive water from unregulated streams, or from streams regulated primarily for power development. The result is that during dry years, there is not sufficient water for all irrigated lands. West of the Sacramento River, irrigation water comes mainly from that river, with secondary additions from tributary streams and pumped ground water. The eastern sub-basin lands are irrigated from the Sacramento, Feather, Yuba, Bear and American Rivers, small tributaries and ground water.

Mineral wealth has always played a dominant role in the economic and social life of the sub-basin. The principal minerals produced include natural gas, gold, stone, sand, gravel and silver. In years past great damage to the rivers and streams of the sub-basin resulted from hydraulic mining of gold in the Sierra Nevada. This was largely stopped when miners were compelled by law to impound the mining debris. Drainage from abandoned copper mines below Shasta Dam and downstream to the mouth of Battle Creek is recognized to be a serious pollution problem.

The lumber industry, like the mining industry, constitutes a potential threat to the purity of the Sierra Nevada waters. In recent years improved legislation has greatly benefited this problem. It is estimated that in 1948 there were over 252 sawmills in the sub-basin, the total amount of lumber sawed being somewhat in excess of one billion board feet.

The Sacramento River together with its numerous tributaries is the principal fishing ground for fresh water and anadromous species in the State. The main anadromous fish--salmon, steelhead, shad, and striped bass--are dependent on the Rivers for spawning grounds. The future of these tremendously valuable fisheries depends on maintaining suitable stream conditions. Departures from natural environmental stream conditions result from the need for harnessing the commercially important water resources of the sub-basin. In the public interest, the problem of minimizing hazards to fish and wildlife is a very real one. General recreational uses of the aquatic environment, increasing continuously, are an equally important natural resource of this sub-basin. These center around the attractive mountain streams in the high Sierras, the Coastal Ranges and Clear Lake, Lake County. The principal forests within the sub-basin boundaries are: Mendocino National Forest, Lassen National Forest, Plumas National Forest, Tahoe National Forest, and El Dorado National Forest.

Summary of Water Pollution Data

There are 46 sewered communities with a combined population of 266,000 discharging domestic and industrial wastes to the water resources of the sub-basin. Twenty-eight of these communities, with a population of 211,000, discharge wastes with a population equivalent of 1,277,400 to surface waters, and the remaining 18 communities discharge wastes with a population equivalent of 68,400 to percolation beds or other land disposal systems. Approximately 86 percent of the wastes discharged to surface water originate in industries connected to municipal sewer systems.

In addition to the industries connected to municipal systems, organic wastes with a population equivalent of 20,000 are discharged from one industry direct to surface water and wastes with a population equivalent of 240,900 are discharged from eight industries direct to percolation beds or irrigated fields. The information on industries is not complete and additional field surveys may show the industrial wastes attributed to industries to be much too low.

Twenty-six of the communities in the sub-basin, with a combined population of 75,000 have provided 26 primary sewage treatment plants for treatment of their wastes. An additional 12 communities with a combined population of 26,400 have provided 12 secondary treatment plants. Eight communities with a population of 164,600 have no waste treatment facilities.

Eight of the 14 known food processing industries have provided waste treatment facilities, two are known to have no waste treatment facilities and the facilities of four are unknown. The waste treatment facilities at the one known petroleum products plant and the four known mining industries have not been determined.

Twenty-five of the 38 municipal waste treatment plants in the sub-basin are considered to be adequate as to design, capacity and degree of treatment provided for present conditions. The remaining 13 treatment plants are considered to be unsatisfactory for present conditions. Operation of 25 of the treatment plants is considered to be satisfactory and operation of 13 to be unsatisfactory.

Seven of the eight existing industrial waste treatment facilities are considered to be adequate as to design, capacity and degree of treatment provided for the present--the other plant is considered to be unsatisfactory for present conditions.

Good progress has been made on municipal waste pollution abatement in the sub-basin in the postwar years. One new treatment plant for a designed population of 18,750 was placed in operation in 1948, 3 new plants designed for a population of 11,300 were placed in operation in 1949, and 10 new plants designed for a combined population of 30,500 were completed and placed in operation during the first 6 months of 1950. Information on industrial waste pollution abatement in the sub-basin is not available.

The requirements for municipal waste treatment plants in the sub-basin are as follows: eight new plants to serve eight communities with a combined population of 164,600 that do not now have waste treatment facilities, five new plants to replace obsolete treatment facilities at five communities with a combined population of 13,600 and eight projects to provide enlargements or additions to existing plants serving eight communities for a combined population of 19,800. The existing facilities for 25 communities are satisfactory for present conditions.

The industrial waste treatment facilities at one of the known industries are unsatisfactory, and require replacement of the existing facilities and the requirements at 11 industries are as yet undetermined.

Of the 21 municipal waste treatment projects needed in the sub-basin, seven are now under construction and plans are being prepared for 11 more. The status of the remaining three projects is undetermined. There are also 18 unsewered communities that may construct public sewers and require treatment facilities.

With increasingly heavy recreational use of the watershed throughout the sub-basin, water treatment plants for camp water supplies and more and better sanitation facilities are needed in the recreational areas.

Much of the flow in the Sacramento River, particularly during the dry season, is water imported from the Shasta Reservoir Sub-Basin. A minimum of 3,300 second-feet of flow is required in the lower Sacramento River to maintain navigation and repel salt water intrusion into the rich delta area; so a minimum of 2,400,000 acre-feet of water annually must flow from the Sacramento River Sub-Basin. Actually, a great deal of the storm run-off is lost due to lack of storage reservoirs. When all the reservoirs planned for the Central Valley Project are completed much of the flood flow that is now lost will be conserved and the surplus exported to the San Joaquin River Valley where there is a deficit.

Irrigation is by far the most important water use in the sub-basin. The water resources are also used for domestic and industrial water supplies to serve the 622,000 persons and industries within the sub-basin, and for commercial and game fishing, stock watering, navigation, bathing and other recreational uses. Quality of the water is generally satisfactory above Sacramento except in a few localized areas, but at Sacramento the river receives raw domestic and industrial wastes with a population equivalent in excess of 1,000,000.

Table A4. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	28 18	211,240[1] 54,800[2]	"To water" *** 1,277,360 "To land" ***68,400
Having population data available (Data on pollution load to watercourse incomplete or not available)	--	--	Not applicable
Total	46	266,040	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

***In the arid west sewage collection and treatment systems discharge not only to watercourses where pollution of surface waters may be a problem but also to land where pollution of underground waters may occur. Accordingly, sources of pollution are broken down into these categories and listed as such in this table.

[1] Industrial wastes with a population equivalent of 1,128,130 increase this total to 1,339,370.

[2] Industrial wastes with a population equivalent of 54,500 increase this total to 109,300.

Table B₄. Sources of pollution, industrial*

Industries	Sources of pollution (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	1 8	"To watercourse" ** 20,000 "To land" ** 240,850
Producing organic wastes	5	Undetermined
Producing inorganic wastes	5	Not applicable
Producing wastes of undetermined type	—	Undetermined
Total	19	—

Note: Industrial waste information is incomplete and additional field data is necessary to complete this table.

*Industries having separate outlets and discharging wastes directly to watercourse or land.

**In the arid west sewage collection and treatment systems discharge not only to watercourses where pollution of surface waters may be a problem but also to land where pollution of underground waters may occur. Accordingly, sources of pollution are broken down into these categories and listed as such in this table.

Table C₄.
Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	26	26	74,994
Secondary	12	12	26,400
No treatment	8	—	164,646

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

Table D₄. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Manufacturing industries:				
Food and kindred products	14	8	2	4
Products of petroleum or coal	1	—	—	1
Nonmanufacturing industries:				
Other mining industries	4	—	—	4

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table E$_4$. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to: Capacity: Satisfactory	Capacity: Unsatisfactory	Capacity: Undetermined	Operation: Satisfactory	Operation: Unsatisfactory	Operation: Undetermined
Municipal	38	25	13	--	25	13	--
Industrial	8	7	1	--	7	1	--

Table F$_4$. Progress in pollution abatement

Year	Municipal: Plants completed	Municipal: Design population	Industrial *: Plants completed	Industrial *: Amount of waste treated (in terms of equivalent number of people)
1946	--	--	--	--
1947	--	--	--	--
1948	1	18,750	--	--
1949	3	11,300	--	--
1950	10	30,500	--	--

*There is such a small amount of data available on industries at the present time that is is impossible to complete this section of the table.

Table G$_4$. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal: Number	Municipal: Population served by facilities	Industrial: Number
New plant	8	164,646	--
Enlargement or additions to existing plant	8	19,760	--
Replace existing plant	5	13,570	1
No project required	25	68,064	7
Undetermined	--	--	11

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

Table H$_4$. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number: Municipal	Number: Industrial
No formal action	--	--
Abatement ordered	--	--
Plans under preparation	11	--
Final plans approved	--	--
Construction awaiting financing	--	--
Under construction	7	--
Status undetermined	3	12

SAN FRANCISCO BAY SUB-BASIN

Description and Economic Development

The San Francisco Bay Sub-Basin comprises 4,410 square miles of lowland coastal and estuarine areas with relatively low mountain ranges. San Francisco, San Pablo, and Suisun Bays are in the center of the sub-basin. Bordering on them are the following counties: Marin, Sonoma, Napa, Solano, Contra Costa, Alameda, Santa Clara, San Mateo and San Francisco.

San Francisco Bay has an area of approximately 450 square miles and a shoreline of over 200 miles. It is about 60 miles in length and from 3 to 14 miles in width. The Sacramento and San Joaquin Rivers, which drain the Central Valley of California, are the main tributary streams and flow through Suisun Bay and Carquinez Strait into the northern end of San Pablo Bay. Among the smaller streams entering the Bay are: Napa River, Petaluma Creek, San Rafael Creek, Walnut Creek, San Pablo Creek, Alameda Creek, Coyote River and Guadalupe River. The maximum length of the sub-basin in a direction parallel to the Pacific Coast is about 85 miles and much of the area extends inland between 40 and 50 miles. North and south of the entrance to San Francisco Bay from the Pacific Ocean, there are coastal mountain ranges with small drainages to the Ocean shores during the winter season. Inland, there are fertile lowlands and mountains ranging northward and southward, Mt. Diablo, one of highest peaks in the Central Coast Ranges, rises to an elevation of 3,849 feet in Contra Costa County.

The climate is mild without pronounced seasonal change and is dominated by coastal fog. Pronounced temperature and precipitation changes accompany small differences in elevation and in distance from the Ocean. Average annual rainfall at San Francisco is 22 inches. Precipitation during the months from November to March, inclusive, ranges from two to five inches per month. The daily mean maximum temperature is 62.6° F. Significantly, the average daily temperature range is 12.2° F. According to a long time record of the Weather Bureau, the sun shines in San Francisco 66 hours out of every 100 possible hours.

Soil cover in the uncultivated areas includes the following trees: eucalyptus, oak, buckeye, Douglas fir, madrona, bay and some redwood. There are large areas of chaparral, brush and grass.

The population of the sub-basin increased from 1,667,800 to 2,520,700 or about 51 percent during the 1940-1950 period. Principal urban centers are: San Francisco (760,753), Oakland (380,576), Berkeley (113,217), Richmond (99,218), San Jose (95,044), Alameda (63,425), San Mateo (41,536), San Leandro (27,498), Redwood City (25,342), and Palo Alto (25,290).

San Francisco is the hub of agricultural exportation for the Central Pacific Coast area of the State. This area contains 77 percent of the California farm acreage and comprises five of the richest agricultural valleys of California. In the sub-basin, the most productive valleys for agriculture include, Napa and Sonoma Valleys on the north, Santa Clara Valley on the south, and Livermore Valley in the eastern part of the sub-basin. In parts of the sub-basin, the soil and climate are suitable for both summer and winter cropping and the lands are intensively cultivated. There are ten kinds of fruits, 16 truck crops, five grains, and 12 classes of flowers and nursery stock produced in commercial quantities on the east side of South San Francisco Bay. Here, processing of foodstuffs is a major industry amounting to several million dollars annually.

Napa Valley, representing the northern part of the sub-basin contains rich agricultural lands. Principal income is from grapes, walnuts, tomatoes, hay and grain, poultry and eggs, dairy products, wool, and meat. Fruit drying and packing plants and large well-known wineries are located in this region.

In Santa Clara Valley on the southern side of the sub-basin, prunes constitute the major orchard crop, followed by apricots, pears, cherries, grapes, and walnuts. Principal vegetable crops include tomatoes, broccoli, celery, peas, cauliflower, snap beans, and bell peppers. The main field crops are alfalfa hay and sugar beets. Beef cattle, dairy and poultry products are important sources of income. Recent years have witnessed a marked industrial expansion in this Valley. Principal manufacturing industries include: food processing; machinery manufacturing; cement and magnesium industries; printing and publishing; and brick, tile, pottery and concrete pipe plants.

In San Francisco, the manufacturing industries comprise a major part of the city's activities, leading its nine major fields of activity in number of employees and amount of payroll. In 1947, about one-fifth of the city employees covered by unemployment insurance were employed by the manufacturing industries. During the war period the ratic rose to one-third. The 1947 total for number of manufacturing units was 2,315 of which 130 employed 100 or more persons.

Regarding the economics of this sub-basin, emphasis needs to be placed on the vast transportation network of the San Francisco Bay area that includes trans-continental rail and highway facilities, air transport services, and steamship lines to foreign ports of the world. In 1948, about 900,000 air passengers were handled, 3,638 steamships departed and there were about 217,000 freight car movements in San Francisco.

The sub-basin has many centers of recreational, cultural, scientific and educational interest. Tourists come to San Francisco throughout the year because of its cultural advantages and scenic beauties. Fishing and boating in the Bay Area and along the Ocean coast attract many sportsmen. Commercial fish landings at San Francisco support important fresh fish and canning industries. In 1947, the total poundage, which was unusually low because of limited sardine landings, amounted to about 15.5 million pounds valued at about 2.3 million dollars.

Minerals produced by counties represented in the sub-basin include: stone, quicksilver, chromite, granite, limestone, manganese ore, pumice, magnesium salts and asphalt.

Summary of Water Pollution Data

There are 132 sewered communities serving an estimated population of 2,420,700 in the San Francisco Bay Sub-Basin, which represents 96 percent of the sub-basin population. Industries contribute an additional population equivalent of approximately 1,890,000 to the sewerage system. Thus, the total equivalent load discharged through the sewers of the sub-basin is approximately 4,311,000. This load is reduced by treatment so that the total population equivalent of discharged wastes is 3,169,000. Of this, 23,400 is discharged to watercourses of the sub-basin, 27,900 to land and 3,117,700 to tidal waters.

Thirty-nine of the communities have 34 primary treatment plants which serve 451,000 persons, and 32 communities have 23 secondary plants serving 185,700 persons. As of July 1, 1950, there were 61 sewered communities serving 1,784,000 persons which had no treatment facilities. Three treatment plants now under construction will provide primary treatment and chlorination for over a million people when completed in 1951.

The design capacity and degree of treatment are considered satisfactory at 29 of the 57 municipal treatment plants and unsatisfactory at 22. The adequacy of design of six plants is undetermined. Operation is considered to be satisfactory at 27 municipal waste treatment plants, unsatisfactory at 23 and undetermined at seven.

Available information indicates that there are 46 industrial plants in the sub-basin which have separate waste outlets. Thirty-two of these plants produce organic waste and the population equivalent of the wastes discharged by 15 of them, for which information is available, is estimated at 625,000. Thirty of the 46 are food processing plants, 15 of which have provided some method of treating their wastes. Twelve are chemical products plants, four of which have waste treatment facilities. The treatment facilities of the remaining four industries, one rubber products and three leather products plants, are undetermined. The adequacy of existing industrial waste treatment facilities has not been determined.

Good progress has been made in pollution abatement programs in spite of increased construction costs and financing problems. One municipal plant waste treatment was constructed in 1946 designed for 1,200; one in 1947 designed for 10,000; three in 1948 designed for 92,000; four in 1949 designed for 115,500 and six in 1950 designed for 79,000. Information is not readily available regarding progress made by industry in preventing pollution.

As of July 1, 1950 there was an indicated need for 54 new municipal waste treatment plants to serve 1,784,000 persons, and for enlargements of or additions to six sewage treatment plants serving 27,500 persons. Twenty-nine plants serving 553,950 were indicated as adequate and the requirements at six others serving 1,400 people were undetermined. Eleven communities with a combined sewered population of 64,500 which are listed as requiring new treatment facilities plan to join with other communities in providing treatment plants. Eleven of the 76 communities requiring treatment works projects have plants under construction, 51 have plans under preparation, and 14 have taken no formal action.

In the past, San Francisco and the Bay Area were considered to be ideally situated with regard to provision of sewerage facilities. Built, for the most part, on hills the cities could lay shallow sewers with adequate grades discharging directly to ample dilution water in the Bays or Ocean. The tremendous growth of the area resulted in excessive loadings at the many individual outlets and overtaxing of the receiving waters near these outlets; nuisances now exist at a number of such places in the sub-basin.

Treatment plant construction was greatly stimulated during the early 1930's when P.W.A. and W.P.A. funds were made available. The next boost in construction came in 1946 when the State Construction and Employment Act of that year made available 45 million dollars to the cities of California for sewage collection and treatment facilities. With the completion of three large

plants now under construction, major problem in the San Francisco and the East Bay Areas will be largely solved.

Table A₅. Sources of pollution, municipal

Municipal- ities*	Sources of pollution (in number of munici- palities)	Population served by sewerage system	Amount of pollution discharged to water- course (in terms of equivalent number of people)**
Having data on pollution load dis- charged to watercourse	"To water- course" *** 17	106,700[1]	23,400
	"To land" *** 14	26,800[2]	27,900
	"To ocean" *** 101	2,287,175[3]	3,117,700
Having popu- lation data available (Data on pollution load to watercourse incomplete or not available)	---	--	Not applicable
Total	132	2,420,675	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

***In the California Basins sewage collectio and treatment systems discharge not only to watercourses where pollution of surface waters may be a problem but also to land where pollution of underground waters may occur and to the ocean where adequate dilution simplifies disposal. Accordingly, the sources of pollution are broken down into these three categories and listed as such in this table.

[1] Industrial wastes with a population equivalent of 127,000 increase this value to 233,700.

[2] Industrial wastes with a population equivalent of 15,000 increase this value to 41,800

[3] Industrial wastes with a population equivalent of 1,747,300 increase this value to 4,034,475.

The same topographical features which permitted simple and economical construction of sewerage systems in early years of Bay area growth act to the disadvantage of present day pollution abatement. The steep slopes to the Bay fostered the construction of many small outfalls and the construction of adequate interceptor sewers now involves high cost construction and pumping. As compared to Los Angeles, where the sewage of twice as many people has been concentrated at two points of treatment; many smaller treatment plants will be required in the San Francisco Sub-basin with ensuing higher construction and maintenance costs.

Table B₅. Sources of pollution, industrial*

Industries	Sources of pollution (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	15	625,000
Producing organic wastes	17	Undetermined
Producing inorganic wastes	13	Not applicable
Producing wastes of undetermined type	1	Undetermined
Total	46	--

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table C₅.
Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipal- ities*	Plants	
Primary	39	34	451,000
Secondary	32	23	185,700
No treatment	61	--	1,784,000

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

Table D_5. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Manufacturing industries				
Food and kindred products	30	15	--	15
Chemical and allied products	12	4	--	8
Rubber products	1	--	--	1
Leather and leather products	3	--	--	3

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table E_5. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	57	29	22	6	27	23	7
Industrial	19	--	--	19	--	--	19

Table F_5. Progress in pollution abatement

Year	Municipal		Industrial*	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	1	1,200	--	--
1947	1	10,000	--	--
1948	3	92,000	--	--
1949	4	115,500	--	--
1950	6	79,000	--	--

*There is such a small amount of data available on industries at the present time that it is impossible to complete this section of the table.

Table G_5. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	54[1,2]	1,784,025	—
Enlargement or additions to existing plant	6	27,500	--
Replace existing plant	16	53,900	—
No project required	29	553,850	—
Undetermined	6	1,400	46

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

[1] Eleven communities serving 64,500 persons listed as requiring new plants are actually planning connection to the facilities of other communities.

[2] Of these plants, one will serve six sources; three will serve two sources each; two will serve one source.

Table H_5. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	14	—
Abatement ordered	—	—
Plans under preparation	51	—
Final plans approved	—	--
Construction awaiting financing	—	--
Under construction	11	—
Status undetermined	6	46

SAN JOAQUIN RIVER SUB-BASIN

Description and Economic Development

The San Joaquin River Sub-Basin comprises a 17,030 square mile area of the Central Valley within the approximate north-south limits of Sacramento and Fresno and between the western Coast Range and eastern Sierra Nevada Mountains. The sub-basin includes all of Calaveras, Madera, Mariposa, Merced, San Joaquin, Stanislaus and Tuolumne counties and parts of Alameda, Alpine, Amador, Contra Costa, El Dorado, Fresno, Sacramento and San Benito counties.

The average annual rainfall in the trough of the San Joaquin Valley ranges from as low as five inches in the southern part to nearly 20 inches near the north end of the sub-basin. In the high Sierra Nevada, the normal annual rainfall may exceed 95 inches and about 85 percent of this precipitation occurs during the period November through April. The climate of the valley floor is characterized by mild winters, hot dry summers and light precipitation. The growing season averages about 275 days.

The principal source of the sub-basin's water supply is the Sierra Nevada drainage area from which the discharge is much greater than from the Coast Ranges. The San Joaquin River (total length, about 340 miles) is one of the major sources of water for irrigation and hydroelectric power. The principal tributaries are the Fresno, Chowchilla, Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne and Cosumnes rivers. These streams originate in the high Sierras and drain innumerable glacial lakelets, some of which are more than 11,000 feet above sea level. The total annual stream run-off (40 year average) in the entire valley averages about 7.8 million acre-feet. In 1944, there were in service 29 hydroelectric generating plants and, since then, at least four more plants are in prospect. There is one completed reservoir, namely, Friant, situated on the San Joaquin River and having a capacity of 520,000 acre-feet, and 13 major prospective storage reservoirs with a total gross capacity of over 6 million acre-feet. Also, three main canals are planned or under construction to meet local irrigation demands and to transport water from the Sacramento and lower San Joaquin Valleys to the upper San Joaquin Valley. The need for water conservation is emphasized by the serious overdraft on ground waters, especially in the East Side Upper San Joaquin Valley.

Glaciation in some of the higher elevations of the Sierra Nevada has removed the soil, formed numerous mountain valleys, and left extensive glacial deposits. Vegetation above an elevation of 8,000 feet is sparse while below to a 2,000 foot level there is usually a good forest cover in places having deep residual soil and sufficient rainfall.

The estimated population of the sub-basin in 1950 is about 576,000, representing an increase of around 55 percent during the last ten years. The principal cities are Fresno, Stockton, Modesto, Merced, and Lodi, accounting for about 36 percent of the total population.

The principal activities within the sub-basin are agriculture and the processing of agricultural products, manufacturing and mining (Chiefly petroleum and gold). The valley floor is a fertile alluvial plain, built by erosion and stream flows from the nearby mountain ranges. The San Joaquin Valley contains more than 6 million irrigable acres, or two-thirds of the potential irrigated cropland in the Central Valley. However, it receives only one-third of the rainfall and stream run-off. It is estimated that 146 sawmills operated in 1948, the production being about 663 million board feet. The principal agricultural crops are vegetables, citrus and deciduous fruits, grapes, nuts, grains, sugar beets, cotton and forage. Pasture lands are extensive. The importance of livestock in the San Joaquin Valley agriculture is indicated by the number of milk cows, being 38 percent, and the number of beef cattle, 29 percent of the State total. It may also be pointed out that 36 percent of California farms having fruit and nuts as a major source of income and 21 percent with fruit crops predominating, are situated in the San Joaquin Valley. The chief industries are canneries, packing plants, grain mills, and other food processing plants.

Principal recreational areas occur at elevations above 2,500 feet in the Sierra Nevada. Recreational requirements are increasing annually, hence, water conservation and the preservation of water quality are primary factors in the continued development of this resource.

Natural cover in the watershed uplands is predominately grassland, and woodland grass in the foothill zones, with pine and fir forest occurring at from 2,500 to 8,000 feet elevation and sub-alpine types scattered throughout the barren areas of high Sierra Nevada. Small areas of chaparral and dense oak woodland occur locally within the timber belt. The preservation and extension of this valuable cover is one of the most important factors in assuring an adequate supply of good quality water in this sub-basin. Appropriately, large areas of the watershed are within the El Dorado National Forest, the Stanislaus National Forest, the Sierra National Forest and the Yosemite National Park.

In the foothill and mountain streams of the east side of the sub-basin, fish are relatively abundant and the streams are usually well stocked. There is a river fishery for catfish, salmon, black bass and sunfish. In the high Sierra streams, trout is the most popular fish.

The slope of the Coastal Range supports a very small fish population due to the intermittent character of the streams. The deer and quail populations, however, are amply provided for by the natural environment. There is need for conserving the available water resources, mainly by caring for the watershed cover through control of erosion, floods, and fires on both public and private lands.

Summary of Water Pollution Data

There are 59 sewered communities with a total connected population of 314,900 in the sub-basin. Twenty-nine of these communities with a combined population of 186,900 discharge wastes with a population equivalent of 323,300 to surface water, 224,000 of the total being from industrial wastes discharged to public sewerage systems. Thirty communities with a combined population of 128,000 discharge wastes with a population equivalent of 393,000 to percolation beds or broad irrigation systems, 318,800 of the total being from industrial wastes discharged to public sewerage systems.

In addition to the industrial wastes discharged to public sewerage systems, there are 61 known industries with separate outlets in the Sub-basin, 20 of which discharge organic waste with a population equivalent of 376,500 to watercourses. The information on industries is not complete and a great deal of additional field work will be required to give the complete picture of the extent of industrial waste problems in the sub-basin.

Thirty-six of the communities in the sub-basin with a combined population of 165,000 have provided primary treatment plants for treatment of their wastes. An additional 15 communities with a combined population of 132,200 have provided secondary treatment plants to give their domestic wastes complete treatment. Eight of the 59 communities have no treatment facilities, but six of these are not completely sewered and are partially served by private septic tanks.

Fifty-eight of the known industries are food processing plants, 13 of which have waste treatment facilities. The treatment facilities provided at the other 45 plants have not been determined. One of the two known lumber and wood products plants has provided treatment facilities. The treatment facilities at the one known mining industry are unknown.

Thirty-two of the 51 domestic sewage treatment plants in the sub-basin are considered to be satisfactory as to designed capacity and degree of treatment provided for present conditions. The remaining 19 plants are considered to be unsatisfactory for present conditions. The information available is not sufficient to determine if the existing industrial waste treatment plants are adequate or not.

Good progress has been made on domestic sewage abatement in the sub-basin during the postwar years. The following new plants or improvements to existing plants have been completed since the end of the war: one plant in 1946 serving a population of 1,000, four plants in 1948 serving a population of 81,600, seven plants in 1949 serving a population of 12,900, and five plants during the first six months of 1950 serving a population of 19,000. There are no complete records available as to the progress made by industries on pollution abatement in recent years, but some industrial waste treatment plants have been constructed.

There are 19 communities where existing waste treatment facilities are believed to be unsatisfactory which with the eight communities that have no treatment makes a total of 27 communities where new or improved facilities are required. Eight of these communities with a combined population of 18,000 will need new plants, ten communities with a combined population of 82,800 need enlargements or additions to existing plants, and nine communities with a population of 54,900 need new plants to replace existing facilities. Six of the places requiring new plants are not completely sewered, and treatment facilities will not be urgently required until additional sewers are provided.

Five of the communities requiring new or improved facilities now have projects under construction, 15 have plans under preparation, and seven have taken no formal action to abate pollution.

Irrigation is the most important water use in the San Joaquin River Sub-Basin, but domestic water supply is also very important. Much of the domestic supply for 1,720,000 persons living in the San Francisco Bay area is imported from the San Joaquin River Sub-Basin. An additional 576,000 persons living in the San Joaquin River Sub-Basin depend upon the water resources for their domestic water and industrial water supply; and sport fishing, stock watering, navigation, bathing, and other recreational uses are also important.

Water quality in the upper reaches of the tributary streams is generally satisfactory, but the quality in the lower San Joaquin River is unsatisfactory for bathing and for public water supply use without special treatment. There are also occasional fish kills due to oxygen depletion during the late summer season when stream flow is at a minimum and waste discharge from food processing industries is at a maximum. The water resources of the sub-basin are inadequate to permit irrigation of all of the irrigable land available, and under the Central Valley plan now being developed surplus water from the Sacramento River will be imported into the San Joaquin Valley to make up the deficit. In some areas now dependent upon ground water supplies for irrigation, the overdraft is so critical that the static water level is dropping as much as ten feet per year.

Table A_6. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	"Watercourse" *** 29	186,900[1]	323,300 (PE of industrial waste 224,000)
	"Land" *** 30	128,000[2]	393,000 (PE of industrial waste 318,800)
Having population data available (Data on pollution load to watercourse incomplete or not available)	--	--	Not applicable.
Total	59	314,900	--

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

***In the arid west sewage collection and treatment systems discharge not only to watercourses where pollution of surface waters may be a problem but also to land where pollution of underground waters may occur. Accordingly, sources of pollution are broken down into these categories and listed as such in this table.

[1] Industrial wastes with a population equivalent of 319,250 increase the total to approximately 506,000.

[2] Industrial wastes with a population equivalent of 319,800 increase the total to approximately 648,000.

Table B_6. Sources of pollution, industrial*

Industries	Sources of pollution (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	20	376,500
Producing organic wastes	40	Undetermined.
Producing inorganic wastes	1	Not applicable
Producing wastes of undetermined type	---	Undetermined.
Total	61	---

Note: List of industries is incomplete and extensive field information is necessary to complete this table.

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table C_6.
Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	36	36	165,000
Secondary	15	15	132,200
No treatment	8	--	17,700

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

Table D_6. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Manufacturing industries:				
Food and kindred products..................	58	13	--	45
Lumber and wood products (except furniture).....	2	1	1	--
Nonmanufacturing industries:				
Mine drainage..........	1	--	--	1

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table E_6. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	51	32	19	0	30	19	2
Industrial	14	--	--	14	--	--	14

Table F_6. Progress in pollution abatement

Year	Municipal		Industrial*	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	1	1,000	---	---
1947	---	---	---	---
1948	4	81,600	---	---
1949	7	12,900	---	---
1950	5	19,000	---	---

*There is such a small amount of data available on industries at the present time that it is impossible to complete this section of the table.

Table G_6. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	8	18,000	---
Enlargement or additions to existing plant	10	82,800	---
Replace existing plant	9	54,900	---
No project required	32	159,200	---
Undetermined	---	---	61

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

Table H_6. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	7	--
Abatement ordered	--	--
Plans under preparation	15	--
Final plans approved	--	--
Construction awaiting financing	--	--
Under construction	5	--
Status undetermined	--	61

SALINAS RIVER AND CENTRAL COASTAL STREAMS SUB-BASIN

Description and Economic Development

The Salinas River and Central Coastal Streams Sub-Basin comprises an area of 7,470 square miles. Extending in a southeasterly direction from Monterey Bay, it embraces all or nearly all of Santa Cruz, Monterey and San Luis Obispo Counties and parts of San Mateo, Santa Clara and San Benito Counties. This drainage area is about 200 miles long and 50 miles wide.

From its source in the northern part of the Los Padres National Forest between Pine Mountains and the Santa Lucia Range, the Salinas River winds in a general northwesterly direction through the fertile Salinas Valley to its mouth in Monterey Bay, about five miles south of Moss Landing. Three important tributaries enter Salinas River from the west; namely, the Nacimiento and San Antonio Rivers and the Arroyo Seco. Two tributaries, Estrella and San Lorenzo Creeks, rise in the eastern mountain ranges. These streams and other tributaries comprise a total drainage area of over 4,000 square miles In the northern part of the sub-basin a coastal slough drainage area, 226 square miles in extent, abuts into the Salinas watershed in the vicinity of Salinas and Castroville. In the southeasterly portion of the sub-basin, there is a closed interior valley of about 600 square miles that drains into Soda Lake, a lake bed having no outlet.

The mountain ranges of the sub-basin range from 3,000 to 5,000 feet in elevation. The Salinas River watershed is separated from the Pacific by the Santa Lucia Range, an unbroken barrier with crest elevations between 3,500 and 5,000 feet; from the San Joaquin Valley by the Diablo Range, and from the San Benito Valley by the Gabilan Range. The Salinas Valley is the largest of the intermountain valleys of the coast range. Its downstream portion is a fertile alluvial plain from two to ten miles in width and with a gradient of about 400 feet in 65 miles.

The natural vegetative cover of the mountainous region surrounding the valley includes several species of oak, pine and low dense brush. Foothills and uncultivated table lands in the valley are covered with grass, and with sage and related shrubs. Scattered growth of willows, baccharis and cottonwoods line the banks of the Salinas River and its tributaries.

Stream slopes in the Salinas River vary from 1.14 feet, or less, per mile from its mouth to Blanco (river mile 7.0) to 14 feet or more per mile near the headwaters above Santa Margarita. The Salinas River channel is wide and shallow and the banks and channel are generally unstable during flood flows causing damage from erosion. The channel capacities vary from 17,000 cubic feet per second at Santa Margarita to 27,000 cubic feet per second at the river mouth on Monterey Bay.

The climate of the river watershed is mild and typical of the central coastal region of California. The climatic year is divided into two seasons--the wet season from December 1 to April 1, and the dry season during the months of June, July, August and September. The mean of the seasonal rainfalls and the mean temperature at three representative valley stations are 12.9 inches and 57.9° F., respectively. Winter and summer temperatures of 16° and 110° F., respectively, have been recorded at valley stations. During summer, night fogs regularly contribute moisture to the farm lands from Monterey Bay to a distance of about 45 miles up the Valley.

The 1950 population of the Sub-basin is 221,400, representing an increase of almost 65 percent since 1940. The largest cities are Santa Cruz, Monterey, San Luis Obispo, Salinas and Watsonville, their 1950 population totalling 77,500, or about 37 percent greater than in 1940.

Agriculture and the processing of agricultural products are the most important occupations in the Salinas River Basin. At Spreckles, there is a sugar-beet factory with a capacity of 5,000 tons of beets per day. Canneries and fruit-drying and packing plants, together with the sugar factory, comprise most of the manufacturing establishments of the Sub-Basin. In 1947, there were 241 manufacturing establishments in Monterey, San Luis Obispo and Santa Cruz Counties, an increase of about 38 percent over the number in 1939. In Monterey County alone the value added by manufacture amounted to over 20 million dollars during 1947.

The principal farm crops are lettuce, carrots, beans, sugar beets, celery, onions, barley, broccoli, artichokes and grain hay. In animal industry, the production of beef cattle, poultry meat, baby chicks and eggs are of primary importance. Fruit and nut crops, including apples, pears, apricots, almonds and walnuts, are grown in large quantities.

Small harbor development and an expansion of the commercial fisheries represent significant trends. Also storage and distribution of petroleum products is an important industry in the Monterey Bay, Estero Bay, and Avila portions of the sub-basin. In Santa Cruz

County there is a large cement plant and a tannery, while limestone and fertilizers are important chemical and mineral industries. In San Luis Obispo County the manufacture of clay products, principally brick and tile, is a valuable industry, important historically.

Recreation is a primary source of income to the sub-basin because of its singular and remarkable attractions and its location near large metropolitan centers. The contrasts of ocean, white sand dunes, pine forests and rocky precipitous shores, with excellent hunting, fishing and other forms of sport, attract thousands of visitors to the area every year. Popular recreational areas within the Sub-basin include Pinnacles National Monument, the north tip of the Los Padres National Forest, the historic locations of seven Spanish Missions, Pismo Beach State Park, Moro Bay State Park, San Simeon Creek Beach State Park, Pfieffer Big Sur Redwoods State Park, Pt. Lobos Reserve State Park, New Brighton and Seacliff Beach State Parks, and Natural Bridges Beach State Park. A unique attraction is the rare sea otters to be seen along the Monterey coast at Pacific Grove and south of Point Lobos.

Surf fishing and off-shore fishing for rockfish, salmon, white meat tuna, and sea bass are popular sports in numerous coastal areas, principally San Luis Obispo Bay, Moro Bay, and Monterey Bay.

The principal mineral products of the watershed are magnesia, dolomite, silica, cement and chromite. In Monterey there was a tremendous expansion of the use of mineral products from a value of $307,177 in 1939 to $4,942,121 in 1924.

Redwood and Douglas fir are the most important timber trees in this sub-basin. During 1946, there were 25 active sawmills in the Santa Cruz County area and five near the coast below the city of Monterey, the total annual production being about 20 million board feet.

Summary of Water Pollution Data

There are 38 sewered communities discharging domestic and industrial wastes to the water resources of the sub-basin. Seventeen of these communities with a combined population of 82,000 discharge wastes with a population equivalent of 26,000 to watercourses, nine communities with a combined population of 19,100 discharge wastes with a population equivalent of 28,000 to percolation beds or other land disposal systems where pollution of surface waters is not a problem, and 12 communities with a combined population of 80,000 discharge wastes with a population equivalent of 87,000 to the Pacific Ocean or tidal salt waters. The total population served by the 38 sewered communities is 181,000 and the total population equivalent of wastes as discharged is 140,000. No population figures could be obtained for three Army Department camps.

In addition to the industrial wastes discharged to community sewer systems, there are 24 known industries discharging organic wastes and one industry discharging inorganic wastes through separate industrial sewerage systems. Twenty-one of these industries are fish processing plants at Monterey and Moss Landing which discharge organic wastes with total population equivalent of approximately 1,650,000 to Monterey Bay. The discharges listed are believed to include most of the major industries, but there may be many minor ones for which no information is available.

Thirty-five of the 38 sewered communities in the sub-basin have provided some type of sewage treatment for their wastes. Twenty-one of the communities have constructed 19 primary treatment plants serving a total population of 78,800, and 14 communities have constructed 13 secondary treatment plants to serve a total population of 76,800. Three communities with a total population of 25,400 discharge raw sewage to the Pacific Ocean.

Two of the 25 known industries in the sub-basin have provided waste treatment facilities, 22 of the industries have no treatment facilities and the pollution prevention measures adopted by one industry are undetermined. Information on industries having separate waste disposal systems, and the effect these discharges are having on receiving areas is meager.

At six of the municipal primary treatment plants the effluent is disposed of to percolation beds or sewage farms so that in effect secondary treatment is provided. Three communities that have been credited with primary treatment provide fine screens and chlorination rather than sedimentation. The effluent from the three plants is discharged to the ocean through a single outfall near where clamming and bathing are the primary water uses.

Twenty-three of the 32 treatment plants in the sub-basin are considered to be satisfactory as to the capacity and degree of treatment provided. Eight of the plants are considered to be unsatisfactory and the adequacy of one is undetermined. Twenty-one of the treatment plants are considered to be satisfactorily operated, operation of six is unsatisfactory, and the adequacy of operation of five plants is undetermined.

The adequacy of the design and operation of the two industrial waste treatment plants is also undetermined.

Good progress has been made on municipal waste pollution abatement in the sub-basin in recent years. One municipal waste treatment plant serving a population of 30,000 was rebuilt in 1946, six plants serving a combined population of 70,000 were constructed or rebuilt in 1949, and additions were constructed for two plants serving a combined population of 23,000 in 1950.

New treatment facilities are required for three communities with a combined population of 25,500, enlargements or additions are required for existing facilities serving seven communities with a combined population of 42,200, and the requirements for one community have not been determined. The existing facilities at 23 communities are satisfactory.

Of the 11 communities requiring municipal treatment projects, one has taken no formal action, nine have plans under preparation and one is under construction. Additional information will be required before an estimate can be made of the pollution preventive measures required by industries. Few complaints are being received by the Regional Water Pollution Control Board, indicating these discharges may not be creating extensive undesirable situations.

There are 12 additional communities that have not been considered as significant sources of pollution as they have not been sewered. All of them have had problems with individual sewage disposal systems, however, and five have plans under preparation for sewerage systems.

The water resources of the Salinas River Valley which comprises the major portion of the sub-basin have been extensively studied by local, State and Federal agencies. Irrigation is the most important water use in the sub-basin, although domestic and industrial water supply and recreational uses are also of major importance. Much of the supply for irrigation, domestic, and industrial use is pumped from wells. The annual overdraft was estimated at 27,000 acre-feet in 1946 with the ultimate overdraft estimated at 76,000 acre-feet. The primary troubles with respect to ground water sources are overdrafts, encroachment of sea water near the coast, and the increase in mineral content from natural soil solubles and applied fertilizers.

Pollution of the main stem of the Salinas River from domestic and industrial wastes is not much of a problem as the river is not a perennial stream in its lower reaches where the major sources of pollution are located. Pollution of the lagoon at the mouth of the river has been a problem, however, and fish-kills have occurred in the past. The effect of wastes, discharged to land disposal systems, on the subsurface water may be of major importance. Pollution of mountain streams through recreational use of these areas, and pollution of coastal waters are also significant problems.

Table A$_7$. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	"To watercourse" *** 17	82,150	25,945
	"To land" *** 9	19,100	27,725
	"To ocean" *** 12	79,775	87,395
			141,065
Having population data available (Data on pollution load to watercourse incomplete or not available)	--	--	Not applicable
Total	38	181,025	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

***In the California Basins sewage collection and treatment systems discharge not only to watercourses where pollution of surface waters may be a problem but also to land where pollution of underground waters may occur and to the ocean where adequate dilution simplifies disposal. Accordingly, the sources of pollution are broken down into these three categories and listed as such in this table.

Table B_7. Sources of pollution, industrial*

Industries	Sources of pollution (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	21	1,650,000
Producing organic wastes	3	Undetermined
Producing inorganic wastes	1	Not applicable
Producing wastes of undetermined type	--	Undetermined
Total	25	--

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table C_7.
Existing treatment facilities, minicipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	21	19	78,825
Secondary	14	13	76,800
No treatment	3	--	25,400

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

Table D_7. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Manufacturing industries:				
Food and kindred products..............	24	2	21	1
Primary metal industries.	1		1	--

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table E_7. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	32	23	8	1	21	6	5
Industrial	2	--	--	2	--	--	2

Table F₇. Progress in pollution abatement

Year	Municipal		Industrial*	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	1	30,000	--	--
1947	--	--	--	--
1948	--	--	--	--
1949	6	70,000	--	--
1950	2	23,000	--	--

*There is such a small amount of data available on industries at the present time that it is impossible to complete this section of the table.

Table G₇. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	3	25,400	--
Enlargement or additions to existing plant	7	42,200	--
Replace existing plant	1	25	--
No project required	23	113,400	--
Undetermined	1	Unknown	25

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

Table H₇. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	1	--
Abatement ordered	--	--
Plans under preparation	9	--
Final plans approved	--	--
Construction awaiting financing	--	--
Under construction	1	2
Status undetermined	1	23

KINGS AND KERN RIVERS AND TULARE LAKE SUB-BASIN

Description and Economic Development

The Kings and Kern Rivers and Tulare Lake Sub-Basin, occupying the most southern sector of the Central Valley of California, comprises an area of 15,500 square miles. The Tulare Lake Basin is a large shallow depression in the trough of the valley which receives floodwaters from Kings, Kaweah and Tule Rivers. The sub-basin includes all of Kings and Tulare Counties and parts of Fresno, Kern and San Luis Obispo Counties.

The principal rivers of the sub-basin are the Kings, Kaweah, Tule, and Kern. The river origins are in glacial lakes and in rugged granitic, mountainous terrain bordered by peaks up to 12,000 feet or more in elevation. As the rivers approach the fertile, alluvial valley floor, they spread out through deeply cut channels and are normally used or dissipated in numerous small delta channels. Prior to the extensive irrigation development of the area, Tulare Lake flowed over the confining ridge into the San Joaquin River, but the last such spill occurred in 1878.

The climate of the sub-basin varies greatly depending on the altitude. Precipitation occurs mainly during the months from November to May with the average seasonal total ranging from 8 inches at Tulare (elevation, 285 feet) to 37 inches at Giant Forest (elevation, 6,360 feet) and with higher amounts occurring at higher elevations. In much of the watershed area above 5,000 feet, precipitation is usually in the form of snow which liberates water slowly throughout the spring and early summer. Characteristically, there are winter flash floods caused by high intensity rains in the foothills and spring floods usually caused by melting of the seasonal snow pack. Difficulties in effective utilization of water as well as great damage result from flash floods, and water conservation efforts are directed to overcome these problems. The average annual run-off (40-year average) in the sub-basin has been estimated to be over 3 million acre-feet. Mountain temperatures range from 20° F. below zero or colder in winter to 90° F. in summer. Average maximum and minimum daily temperatures on the valley floor approximate 80° and 50° F., respectively.

The high Sierra ranges are of recent origin. Bare granite slopes predominate above the 10,000 foot level and there is practically no vegetation. At the lower elevations the soil becomes thicker with heavy timber at mid-level areas. The southern and eastern areas are exceedingly dry and vegetative growth is often confined to juniper and sagebrush. In the foothills, much of the soil cover consists of native grasses.

The estimated 1950 population of the sub-basin is 650,200 representing an increase of about 52 percent since 1940. Five principal cities include Bakersfield, Delano, Hanford, Tulare, and Visalia, having an aggregate population of 76,500.

Agriculture, food processing, and the production of petroleum and other minerals are the principal income producing activities. During 1949, the acreage in the counties of Kings, Tulare and Kern, in field crops was 1,097,814 with a production of 1,904,370 tons; in fruit crops it was 179,254 with a production of 762,230 tons; and the truck crops acreage was 91,483, the equivalent tonnage being 978,600. Total agricultural production value for the year was $385,523,370. Much of the economy is dependent upon irrigation. In the eastern part of the sub-basin the greater part of the winter and surplus spring run-off is supplied to the immense ground-water reservoirs by percolation into the flat alluvial cones of the major stream. The total capacity of these ground-water basins has been estimated by the California Division of Water Resources at 20 million acre-feet within the range of feasible pumping lifts.

Current use of water for irrigation is excessive and has lowered the water table to a dangerously low level. The estimated average acreage irrigated in the sub-basin is over 1,200,000, the net water requirement being about 3 million acre-feet.

The sub-basin is exceptionally rich in petroleum and natural gas. Their production value in 1947 exceeded 200 million dollars.

In 1948, there were about 27 active sawmills in the sub-basin, the total amount of lumber sawed being approximately 81 million board feet.

Recreation is an important industry. It centers in the Kings Canyon National Park, Sequoia National Forest, Sequoia National Park, and Sierra National Forest. Attention is called to the historically important waterfowl use of the Tulare and Buena Vista lakes in this sub-basin.

Summary of Water Pollution Data

There are a total of 45 sewered communities with a combined population of 164,300 in the sub-basin. Only four of the communities with a combined population of 7,700 discharge wastes, with a population equivalent of 3,900, to watercourses where pollution of surface waters may be a problem. The remaining 41 sewered communities, with a connected population of 156,600 and known industrial wastes with a population equivalent of 162,000, dispose of treated effluent with a population equivalent of 101,600 to land where the effect on sub-surface waters is the most important consideration.

In addition to the domestic sources of pollution and the industries connected to public sewer systems, there are 91 known industries producing organic wastes and one known industry producing inorganic wastes with separate waste discharges. It is believed that all of these industries dispose of their wastes to percolation beds or other land disposal systems, so that the pollution of surface waters is not a problem. A great deal of additional industrial waste information is needed to give the complete picture, however, particularly as to the effect of industrial waste discharges on sub-surface waters.

All of the 45 sewered communities in the sub-basin have provided some type of sewage treatment. Fourteen of the communities, with a combined population of 61,700 have provided secondary treatment utilizing trickling filters or other types of biological processes. Eleven of these communities provide percolation beds or other land disposal systems in addition to secondary treatment. The remaining 31 communities, with a combined population of 102,600, have provided primary treatment and 29 of the 31 use the primary effluent for irrigation of crops in season or dispose of it to desert lands, so that in effect complete treatment is accomplished most of the time.

It is believed that all of the known industries in the sub-basin also dispose of their industrial wastes to land, so that the effect on sub-surface waters is of primary importance.

Thirty of the 45 municipal treatment plants are considered to be adequate as to designed capacity and degree of treatment provided, while 12 are considered to be unsatisfactory, and the adequacy of three is undetermined.

Operation of 33 of the municipal treatment plants is considered to be satisfactory, operation of eight of the plants is unsatisfactory, and the adequacy of operation at four plants is undetermined.

The design of 12 of the industrial waste treatment plants is considered to be satisfactory as to design capacity and degree of treatment provided for present conditions, and the design of eight is considered to be unsatisfactory. Not enough information is available regarding the remaining 71 industries to permit judging the adequacy of design of the waste treatment facilities. The operation of 12 of the industrial waste plants is considered to be satisfactory, 8 unsatisfactory and 71 undetermined.

Excellent progress has been made in recent years on municipal waste pollution abatement in the sub-basin. Seven communities with a combined population of 36,100 constructed treatment facilities in 1949, and six with a combined population of 28,400 constructed treatment facilities during the first six months of 1950.

Of the 12 sewered communities with inadequate waste treatment facilities, five plants serving a population of 15,800 need to be replaced with new plants, and seven serving a population of 57,100 need enlargements or additions to existing plants. Ten of the 12 communities requiring improved facilities now have plans for the needed improvements under preparation, but the remaining two communities have taken no formal action toward provision of the necessary improvements.

Eight of the industrial waste treatment facilities are considered to be unsatisfactory, but no information is available as to the steps being taken to improve or replace these facilities. Additional information is also needed as to the facilities required at 72 of the known industries.

In addition to the 45 sewered communities, there are 22 smaller unsewered places where problems have occurred in recent years with individual sewage disposal systems. Some of these communities will no doubt eventually construct public sewer systems.

Pollution of surface waters is not a major problem in the sub-basin as there are few perennial streams in the lower valleys where most of the domestic and industrial sources of pollution are located. There is no surface water exported from the sub-basin, and all domestic and industrial wastes are reclaimed either through irrigation of crops or by percolation into natural or prepared beds. Even the watercourses function as percolation beds, and the small amount of wastes discharged to them soon disappears. Since domestic, industrial, and irrigation water supplies come largely from wells, the effect of waste discharge on the quality of the ground water is of utmost importance.

Table A_8. Sources of pollution, municipal

Municipal-ities*	Sources of pollution (in number of munici-palities)	Population served by sewerage system	Amount of pollution discharged to water-course (in terms of equivalent number of people)**
Having data on pollution load dis-charged to watercourse	"To water-course" *** 4 "To land" *** 41	7,695 156,610[1]	3,900 101,605
Having population data available (Data on pollution load to watercourse incomplete or not available)	--	--	Not appli-cable.
Total	45	164,305	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

***In the arid west sewage collection and treatment systems discharge not only to watercourses where pollution of surface waters may be a problem but also to land where pollution of underground waters may occur. Accordingly, sources of pollution are broken down into these categories and listed as such in this table.

[1] Industrial wastes with a population equivalent of 162,000 increase this total to 318,610.

Table B_8. Sources of pollution, industrial*

Industries	Sources of pollution (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	--	--
Producing organic wastes	91	Undetermined, All to land.
Producing inorganic wastes	1	Not appli-cable.
Producing wastes of undetermined type	--	Undetermined.
Total	92	--

*There is such a small amount of data available on industries at the present time that it is impossible to complete this table.

Table C_8.
Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipal-ities*	Plants	
Primary	31	31	102,634
Secondary	14	14	61,671
No treatment	---	---	---

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

Table D_8. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Manufacturing industries:				
Food and kindred products	91	91**	--	--
Nonmanufacturing industries:				
Mine drainage	1	--	--	1

*Industries having separate outlets and discharging wastes directly to watercourse or land.

**Percolation beds or other land disposal methods.

Table E_8. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	45	30	12	3	33	8	4
Industrial	91	12	8	71	12	8	71

Table F_8. Progress in pollution abatement

Year	Municipal		Industrial*	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	--	--	--	--
1947	--	--	--	--
1948	--	--	--	--
1949	7	36,100	--	--
1950	6	28,500	--	--

*There is such a small amount of data available on industries at the present time that it is impossible to complete this section of the table.

Table G_8. Requirements for municipal and industrial waste treatment plants**

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	0	--	--
Enlargement or additions to existing plant	7	57,088	—
Replace existing plant	5	15,820	--
No project required	30	88,085	12
Undetermined	3	3,312	80*

*Industrial wastes to land - possible need of larger disposal areas and better operation.

**The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

Table H_8. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	2	--
Abatement ordered	—	—
Plans under preparation	10	--
Final plans approved	—	—
Construction awaiting financing	--	--
Under construction	--	--
Status undetermined	3	80

SANTA MARIA AND SANTA YNEZ RIVERS SUB-BASIN

Description and Economic Development

The Santa Maria and Santa Ynez Rivers Sub-Basin, located on the Southern California coast in the latitude of Point Conception, has an area of 3,450 square miles. The watershed boundaries approximate a rectangle in shape, enclosing the major part of the Los Padres National Forest and including the Sierra Madre and San Rafael Mountains inland and the Santa Ynez Mountains along the south coast. The sub-basin includes all of Santa Barbara County, a small southern portion of San Luis Obispo County, and a northwest tip of Ventura County. The San Rafael and Santa Ynez Mountains converge toward the east in a rugged mountain block which forms the headwaters of the Santa Ynez River that flows in a westerly direction to enter the Pacific Ocean at Surf, north of Point Arguello. The Santa Maria River is formed by the Sisquoc River, a short tributary that originates in the northern part of the San Rafael Mountains and the Cuyama River originating also in these mountains, flowing in a northwesterly direction, and cutting through the Sierra Madre Mountains. The Santa Maria River follows a general westerly course entering the Pacific Ocean about 20 miles north of the Santa Ynez River in South San Luis Obispo Bay near Guadalupe.

The watershed comprises three physiographic types--lowlands, foothills, and mountains--but by far the largest area is mountains. Tributaries of the main river channels, carved along fault zones, range from 6 to 20 miles in length. Their gradients are steep, averaging from 2 to 6 percent. Mean annual precipitation varies from less than 15 inches in the valleys to more than 35 inches in the mountains where the seasonal range is 15 to 75 inches. Ninety percent of the seasonal precipitation occurs during the period November 1-April 30. The climate is characterized by long dry summers and mild winters. During the dry season the humidity drops very low in the central part of the drainage area and the temperature often exceeds 100° F. In the coastal area summer fogs are prevalent. At Santa Barbara, south of Point Conception, the average July temperature is 67.3° F. and the January average is 53.3° F. Killing frosts occur, but they are so infrequent that there is an exceptionally long growing season of 331 days.

Major vegetation cover types in the watershed are barren areas, semi-barren areas, grassland, dry-farmed cropland, irrigated cropland, sage grass, chamise chaparral, mixed chaparral, woodland grass, oak woodland, and stands of miscellaneous conifers such as species of pine and fir. It has been estimated that fairly serious floods have a frequency of 15 in 100 years.

The population of the sub-basin in 1950 is 106,900 or nearly 40 percent greater than in 1940. There are only three sizeable centers of population; namely, Santa Barbara (44,800), Santa Maria (10,400), and Lompoc (5,500).

Agriculture provides the major source of income to the sub-basin. In 1949, the total agriculture production for Santa Barbara County, the principal agriculture area of the sub-basin, was about 53 million dollars.

The crop value was nearly 35 million dollars and the income from livestock about one-half as much. During 1949, out of a total land area in the County of 1,756,800 acres, there were 893,884 acres in farms and 185,329 in crop land. There were 1,381 farms. The average size per farm is over 600 acres. Vegetable crops are the most valuable, the next in order being dairy products, field crops, and fruits and nuts. Lemons, cauliflower, celery, tomatoes, beans, potatoes, peppers, broccoli, carrots and sugar beets have individual annual values of over one million dollars.

Santa Barbara County, which comprises the major portion of the sub-basin, is an important oil producing area. The Santa Maria Valley fields produced about one-half of the 21 million dollar County total for 1944. In 1947, petroleum production amounted to over 22 million barrels valued at about 33 million dollars. Diatomite is an important product. Near Lompoc is the world's largest known deposit of high quality diatomaceous earth. Other commercial mineral products include asphalt and bituminous rock, barytes, brick, chromite, copper, gypsum, limestone, quicksilver, and miscellaneous stone.

Principal industries are food processing, printing and publishing, and oil refining. Lesser manufacturing enterprises include a sugar beet refinery, box factories and planing mills, machine shops and clay and concrete products.

Most of the Los Padres National Forest is within the boundary of the sub-basin. This area provides a valuable water supply and a source of recreation. It is significant to the flood problem because it occupies the areas of roughest topography, receives the greatest precipitation and contributes most of the river run-off. Besides providing important surface water supplies for Santa Barbara, the wildland mountainous areas are the major sources of waters for recharging underground basins in the Santa Ynez and Lompoc Valleys. Erosion from the wildlands is important. The debris accumulates in the streams, obstructs the flows, and silts the reservoirs. Records of sedimentation in Gibraltar Reservoir situated in the San Rafael Mountains, for the past 20 years indicate an average rate of almost 3,000 cubic yards per square mile per year due to excessive burning of the watershed cover. Flood damage has also been caused by the cutting away of large areas of agricultural bottom land and by the deposition of sterile sands on fertile bottom lands.

Shortage of water on the coast has made it necessary to import water across the coast range from the Santa Ynez River. Up to May 31, 1949, the coastal area received only 11 inches of rainfall, continuing the sub-average which prevailed since 1944. A new reservoir at the Cachuma Dam site is planned to meet an increasingly serious shortage of water. Meanwhile Santa Barbara is endeavoring to meet the problem by making heavier drafts on wells and searching for new ones. To date, the wells have not proved adequate and the city has been forced to draw upon the meager supply in Gibraltar Reservoir. The wells in the outlying areas show dangerous drops from 10 to 80 feet during the period 1945-1949.

The sub-basin is a principal recreational area in California. The Santa Ynez is reputed to be the best steelhead river in the southern part of the State, the annual run of adults being estimated at 20,000. However, the run can enter the river only when the river carries enough flow to break through the bar at the mouth.

A game survey by the California Division of Fish and Game showed that the 1948 deer kill was about 700 in Santa Barbara County. Surf fishing and off-shore sport fishing are additional recreational attractions.

Summary of Water Pollution Data

There are 13 sewered communities discharging wastes to the water resources of the sub-basin. Five of these communities with a combined population of 7,800 discharge wastes with a population equivalent of 3,200 to watercourses, five communities with a population of 12,750 discharge wastes with a population equivalent of 3,400 to land, and three communities with a population of 39,000 discharge wastes with a population equivalent of 32,000 to the Pacific Ocean.

In addition to the industries discharging wastes to public sewers, there are nine known industries discharging wastes through separate outlets. Six of them produce organic wastes and three produce inorganic wastes. The population equivalent of wastes as discharged from five of the six plants producing organic wastes is estimated at 3,800. The discharges listed are believed to include most of the major industries, but there are many minor ones for which no information is available.

Eleven of the 13 sewered communities have provided sewage treatment facilities for their wastes. Three of these 11 communities with a total population of 37,700 have provided primary treatment plants, and the other eight with a combined population of 17,850 have provided secondary treatment plants. The remaining two communities with a population of 4,000 have no sewage treatment facilities, one discharging raw sewage to the Pacific Ocean and one discharging raw sewage to the Santa Maria River. Treatment plants have been financed for these two communities, and construction should be started in the near future.

Two of the six industries with organic wastes have provided waste treatment facilities, and at four of the plants the pollution prevention measures that have been adopted have not been determined. None of the three industries with inorganic wastes has waste treatment facilities. Information on industries having separate waste disposal systems, and the effect these discharges are having on receiving areas is meager.

Nine of the eleven sewage treatment plants in the sub-basin are considered to be satisfactory as regards design capacity and degree of treatment provided and two are considered to be unsatisfactory. Operation of eight of the treatment plants is considered to be satisfactory, one is unsatisfactory, and at two it is undetermined. Adequacy of the design and operation of the two known industrial waste treatment plants have not been determined.

Good progress is being made on pollution abatement in the sub-basin. Three municipal waste treatment plants serving a combined population of 15,550 were constructed or rebuilt in 1946. One community with a population of 35,000 is constructing needed additions to its present plant, one community with a population of 2,500 has plans under preparation for additions to its existing plant, and two communities with combined population of 4,000 have plans under preparation for new treatment plants.

When the plant now under construction and the three plants now in the planning stage are completed, all of the significant sources of municipal pollution in the sub-basin will have been provided with treatment facilities. Additional information will be required before an estimate can be made of the pollution prevention measures required by industries. Few complaints are being received by the Regional Water Pollution Control Board as to damage from industrial waste discharges indicating these discharges may not be creating extensive undesirable situations.

The sub-basin is a part of the water deficient Central Coastal Area of California which has approximately two million acre-feet of the

70 million acre-feet annual total of water estimated for the State. There were critical shortages in the Santa Barbara domestic water supply in 1931 and again in 1948 when emergency water rationing ordinances were placed in effect to conserve the supply. The Cachuma project now under construction by the Bureau of Reclamation on the Santa Ynez River will assure adequate domestic water supplies for the sub-basin for some time, but will not provide an adequate supply for irrigation.

Table A_9. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	"To watercourse" *** 5	7,800	3,230
	"To land" *** 5	12,750	3,435
	"To ocean" *** 3	39,000	32,350
			39,015
Having population data available (Data on pollution load to watercourse incomplete or not available)	—	—	Not applicable
Total	13	59,550	—

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

***In the California Basins sewage collection and treatment systems discharge not only to watercourses where pollution of surface waters may be a problem but also to land where pollution of underground waters may occur and to the ocean where adequate dilution simplifies disposal. Accordingly, the sources of pollution are broken down into these three categories and listed as such in this table.

Quality of the water is generally satisfactory as the major sources of pollution are located in the lower valleys where there are no perennial streams. There is danger of contamination from recreational use of reservoirs and catchment areas, however, and such use should be carefully planned and supervised.

Table B_9. Sources of pollution, industrial*

Industries	Sources of pollution (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	5	3,800
Producing organic wastes	1	Undetermined
Producing inorganic wastes	3	Not applicable
Producing wastes of undetermined type	—	Undetermined
Total	9	--

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table C_9.
Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	3	3	37,700
Secondary	8	8	17,850
No treatment	2	—	4,000

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

Table D_9. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Manufacturing industries:				
Food and kindred products	6	2	--	4
Nonmanufacturing industries:				
Oil production industry..	3	--	3	--

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table E_9. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	11	9	2	--	8	1	2
Industrial	2	--	--	2	--	--	2

Table F_9. Progress in pollution abatement

Year	Municipal		Industrial*	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	3	15,550	--	--
1947	--	--	--	--
1948	--	--	--	--
1949	--	--	--	--
1950	--	--	--	--

*There is such a small amount of data available on industries at the present time that it is impossible to complete this section of the table.

Table G_9. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	2	4,000	—
Enlargement or additions to existing plant	2	37,500	—
Replace existing plant	—	—	—
No project required	9	18,050	—
Undetermined	—	—	9

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

Table H_9. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	—	—
Abatement ordered	—	—
Plans under preparation	3	—
Final plans approved	—	—
Construction awaiting financing	—	—
Under construction	1	—
Status undetermined	—	9

SANTA CLARA RIVER SUB-BASIN

Description and Economic Development

The Santa Clara River Sub-Basin, situated along the Pacific Coast north of Los Angeles, has an area of 2,610 square miles. About two-thirds of the sub-basin lies in Ventura County and the remainder in the rural northwest part of Los Angeles County.

The main drainage systems empty into the Santa Clara River, the Ventura River and the Calleguas Creek and comprise an area of 2,230 square miles. These three watercourses flow through alluvial valleys and then spread out upon the flat coastal Oxnard Plain. The smaller streams of the northern and southern parts of the sub-basin drain into the Ocean through coastal valleys.

The terrace deposits of late Pleistocene age are consolidated gravels, sand and clays of terrestrial origin laid down as flood plains or alluvial fans. These reddish colored deposits are permeable and their importance as underground reservoirs depends on the local structure. Rainfall is scanty. At Oxnard, it averages 12 inches per year. In the mountains, it varies from nine to thirty inches with semi-snow at higher elevations which quickly melts. There are two seasons, wet and dry, with 78 percent of the precipitation occurring from December to March, inclusive.

The 1950 population of the sub-basin is 123,000, representing an increase of about 61 percent since 1940. The largest cities are Oxnard (21,512), Ventura (16,532), and Santa Paula (11,034).

Major incomes of the sub-basin are from agricultural and mineral products, chief of which is petroleum. Agriculture and the processing of agricultural products are principal occupations and the agricultural lands are largely confined to Ventura County. The production figures for this county express approximately those of the sub-basin. Normally, Ventura County produces more lemons, walnuts, and large lima beans than any other county in the State. It ranks fourth in the production of avocados and fifth in the yield of oranges. Almonds, deciduous fruits, grain, nursery stock, vegetable and flower seeds, poultry and bee products all add to the annual (1949) income from farm products of over 65 million dollars. The total crop production tonnage in 1949 for Ventura County (roughly equivalent to the sub-basin tonnage) was 428,950 of which the fruit crop tonnage was 305,590. The second largest beet sugar refinery in the world, with a daily capacity of about 3,600 tons of sugar beets, helps to put food manufacturing in second place. Other food manufacturers include producers of soft drinks, bakery products, canned and dried fruits, animal feeds, meat packing establishments and several small wineries. Machinery ranks third in production.

With the exception of beans and deciduous trees, crops require irrigation. Most of the irrigation supplies are procured from wells sunk into the alluviums of the valley fill. The estimated mean annual run-off for the period 1892-1932 was 214,000 acre-feet in the Santa Clara River and 60,000 acre-feet in the Ventura River. In respect to both salinity and boron concentrations, by 1933 the water supply of the Santa Clara Valley was close to the limit of tolerance for the more sensitive crops. Hence, emphasis is placed on the quality of available supplies of irrigation water.

The principal mineral resource of the sub-basin is petroleum, the 1947 yield being 27 million barrels valued at about 49 million dollars. Other minerals include: natural gas, asphalt, bituminous rock, borax, clay, gypsum, limestone, mineral water, mineral paint, molding sand, sandstone, flagstone, crushed rock, sand and gravel, gold, silver and lead.

The north and northeast sectors of the sub-basin are mountainous and include the Angeles National Forest, an important recreational center. Over 85 miles of shoreline provide abundant recreation in the form of bathing, boating and fishing.

Summary of Water Pollution Data

There are ten sewered communities with a combined population of 75,500 in the Sub-basin. Three of the communities with a population of 15,200 discharge wastes with a population equivalent of 6,300 to watercourses, three of the communities with a population of 8,500 discharge wastes with a population equivalent to 3,400 to land, and four communities with a population of 51,800 discharge wastes with a population equivalent of 45,500 to the ocean.

There are six industries in the sub-basin, for which information is available, that have separate waste discharges. Three of the industries discharge organic waste with a population equivalent of 40,800, one of the industries is a fish cannery that has not been in operation for several seasons, and two of the industries are oil producing fields producing inorganic wastes.

All of the sewered communities in the sub-basin have provided treatment facilities for their wastes. Five of the communities with a combined population of 30,000 have provided five primary treatment plants and five communities with a population of 45,500 have provided secondary treatment plants. Three of the six industries have also provided treatment facilities for their wastes.

Table A_{10}. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	"To watercourse" *** 3	15,150	6,300
	"To land" *** 3	8,500	3,400
	"To ocean" *** 4	51,800[1]	45,500
			55,200
Having population data available) (Data on pollution load to watercourse incomplete or not available)	--	--	Not applicable
Total	10	75,450	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

**Includes industrial wastes discharged into municipal sewage systems.

***In the California Basins sewage collection and treatment systems discharge not only to watercourses where pollution of surface waters may be a problem but also to land where pollution of underground waters may occur and to the ocean where adequate dilution simplifies disposal. Accordingly, the sources of pollution are broken down into these three categories and listed as such in this table.

[1] Industrial wastes with a population equivalent of 40,000 increase this total to 91,800.

Five of the ten municipal waste treatment plants in the sub-basin are considered to be satisfactory during critical periods, as regards the designed capacity and degree of treatment provided. The five remaining plants are either of inadequate capacity or do not provide the degree of treatment required for present conditions. Enlargements, or additions should be provided to four of the existing plants, and one plant should be replaced.

The waste treatment facilities now provided by three of six industries are not satisfactory for present conditions. New facilities are required at the three industrial plants which now have no treatment and additions or enlargements are required at the three industries where existing facilities are inadequate.

Some progress has been made on pollution abatement in the sub-basin during the post-war years, but treatment facilities generally have not kept pace with the rapid population increase. Treatment facilities were constructed in 1946 to serve one community of 2,000 population and facilities were also provided to serve one industry. In 1947 facilities were constructed for one community of 20,000 population, and in 1948 facilities were constructed for one community of 2,000 population.

No formal action has been started by any of the five communities with unsatisfactory facilities to provide the necessary enlargements or additions. The status of the treatment works projects needed by industries is undetermined.

Table B_{10}. Sources of pollution, industrial*

Industries	Sources of pollution (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	3	40,800
Producing organic wastes	1	Undetermined
Producing inorganic wastes	2	Not applicable
Producing wastes of undetermined type	--	Undetermined
Total	6	--

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table C_{10}.
Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipal-ities*	Plants	
Primary	5	5	29,950
Secondary	5	5	45,500
No treatment	0	--	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

Table D_{10}. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Manufacturing industries:				
Food and kindred products...............	4	2	2	--
Nonmanufacturing industries:				
Oil production industry.	2	1	1	--

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table E_{10}. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satis-factory	Unsatis-factory	Unde-termined	Satis-factory	Unsatis-factory	Unde-termined
Municipal	10	5	5	--	5	5	--
Industrial	3	--	3	--	1	2	--

Table F_{10}. Progress in pollution abatement

Year	Municipal		Industrial*	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	1	2,000	1	--
1947	1	20,000	--	--
1948	1	2,000	--	--
1949	--	--	--	--
1950	--	--	--	--

*There is such a small amount of data available on industries at the present time that it is impossible to complete this section of the table.

Table G_{10}. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	--	--	3
Enlargement or additions to existing plant	4	42,150	3
Replace existing plant	1	1,000	--
No project required	5	32,300	--
Undetermined	--	--	--

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

Table H_{10}. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	5	--
Abatement ordered	--	--
Plans under preparation	--	--
Final plans approved	--	--
Construction awaiting financing	--	--
Under construction	--	--
Status undetermined	--	6

LOS ANGELES RIVER SUB-BASIN

Description and Economic Development

The Los Angeles River Sub-Basin comprises an area of 11,790 square miles, situated on Santa Monica Bay between the Santa Clara River and Santa Ana River Sub-Basins. The San Gabriel Mountains form its Northeastern boundary and separate its fertile agricultural lands from the arid and desolate Mojave Desert. The west barrier of the sub-basin is the Simi Hills extending northward from the Santa Monica Mountains to the Santa Susana Mountains.

The Los Angeles River originates in low hills and mountains bordering the westerly portion of the San Fernando Valley, flows eastward about 20 miles along a depression near the south edge of the valley, cuts through the intermediate range at Los Angeles Narrows, trends southward for about 30 miles across the coastal plain, and then enters the ocean at Long Beach. The State Division of Water Resources has estimated that this river and its tributaries discharge an average of about 130,000 acre-feet annually into the valleys; that an annual coverage of about 400,000 acre-feet of precipitation falls in these valleys; and that annual discharge to the ocean averages about 65,000 acre-feet.

Included in this sub-basin is the San Gabriel River watershed, embracing about 214 square miles of the higher portions of the San Gabriel Mountains where the river originates. This river flows 14 miles in a southwest direction to Whittier Narrows, then southward for about 20 miles to enter the ocean at Alamitos Bay east of Long Beach. According to the State Division of Water Resources the San Gabriel River and its tributaries discharge an average of about 70,000 acre-feet annually into the valley from mountains and hills. The annual coverage of precipitation in the valley is about 200,000 acre-feet. The annual discharge into the ocean averages about 20,000 acre-feet. Both rivers, however, are virtually dry throughout most of the summer season.

The watershed mountains are steep and rugged, whereas the hills are sloping and more rounded. Average rainfall at the higher elevations may reach 30-36 inches annually. A large part of the coastal plain is relatively smooth, with a gentle slope at right angles to the shoreline.

The climate of the sub-basin is marked by a relative uniformity of temperature and a wide variation in precipitation, both in space and time. At Los Angeles (elevation 300 feet), 14 miles from the ocean, the mean temperature is 63° F. and the range is from 28 to 109 degrees. At elevations of over 5,000 feet, temperatures range below zero in winter. Throughout the greater part of the valley area damaging frosts occur for short periods only, and they are rarely so severe that heating will not prevent loss of semitropical crops. Mean annual precipitation varies from about 12 inches along the coast to 36 inches in the mountains. On the average only 16 percent of the annual total rainfall occurs during the principal growing season, April to October. Accordingly, irrigation is necessary for most crops in all but the very retentive soils.

The basement complex and older sedimentary rocks, of which the mountains and hills are the surface expression, are in general so dense that extraction of ground water from them is not practical and movement of water through them is insignificant. The more porous valley fill which overlies this bedrock is, however, the immediate source of a large water supply. Beneath the heavily populated coastal area are the great natural underground water storage basins. These are prehistoric lakes and valleys that have been filled with eroded materials including sand, gravel, clay and earth. These alluvial fills may be over 1,500 feet in depth. Over 500 municipal and private water companies and thousands of private individuals and concerns depend entirely upon these basins for their supplies of water. Wet and dry cycles are reflected in the depth of the water table which may be drawn down as much as 100 feet during a prolonged dry cycle.

The scarcity of water for the Los Angeles Metropolitan Area led to construction of the 238 mile long Owens River aqueduct in 1908-1913 to bring in water from the Owens River sub-basin of the Great Basin. This additional supply soon proved to be inadequate for the rapidly growing city and preliminary studies were started by the City of Los Angeles in 1923 to determine the feasibility of obtaining additional water for community water supplies from the Colorado River. The Metropolitan Water District Act was enacted by the California Legislature in 1927 permitting formation of the Metropolitan Water District of Southern California in 1928, with 11 member cities to finance the project. Actual construction was started on the project in 1932 and first delivery of softened Colorado River water was made to the member city of Pasadena in 1941.

The asserted entitlement to Colorado River water by the State of California is approximately five million acre-feet annually. When the Colorado River aqueduct is enlarged to its intended ultimate capacity, it will be capable of delivering no more than the asserted entitlement of the Metropolitan Water District of Southern California, namely, 1,212,000 acre-feet annually, to the coastal areas of the five counties of Southern California: Los Angeles, Orange, Riverside, San Bernardino, and San Diego. During the 1948-49 water year, the total supply of the Colorado River was estimated to be 14,900,000 acre-feet of which 3,275,000 acre-feet were used by California agricultural projects, and 172,300 acre-feet were used by the Metropolitan Water District.

The availability of Colorado River water to meet community water supply demand guarantees security from future water shortage to every constituent of the Metropolitan District. The certainty of an ample water supply was a determining factor in the location of many war industries in this coastal area, and the water supply from the Colorado River aqueduct made possible the training of many soldiers and airmen by the War Department in the open desert regions of Southern California.

The 1950 population of the sub-basin is about 4,096,500, representing an increase of nearly 50 percent since 1940. The population of Los Angeles City is 1,954,000 and the remaining principal population centers are: Long Beach (243,921), Pasadena (103,971), Glendale (94,993), Burbank (78,224), and Santa Monica (70,843).

Most of the rich agricultural areas of Los Angeles County are within this sub-basin, hence the county figures used here are indicative of the sub-basin yields. Los Angeles is the only county in the United States that is able to accommodate approximately four million people and still maintain its agriculture. For many years it has led all counties in the nation in value of agricultural production. In 1949, total crop and livestock production values were $87,097,500 and $112,058,630, respectively. Total agricultural production value for the county was nearly 200 million dollars. The total crop acreage in 1949 was over 250,000 and the total crop production tonnage was 1,013,200. The dairy industry amounted to 64 million dollars and the chicken-eggs industry 23 million dollars. Other industries producing annually over a million dollars worth of products are: nursery stock, oranges, cut flowers, lemons, alfalfa, cattle and calves, chicken meat, celery, rabbit meat and fur, hogs, turkey meat, tomatoes, walnuts and cauliflower. According to the Census of Agriculture there were, in 1945, about 13 thousand farms valued at over 344 million dollars in Los Angeles County.

The largest hay market in the world is in Los Angeles County with more than a half-million tons hauled from 75 to 300 miles each year. Dairying is a highly specialized factory operation.

Most of the mountain area of the sub-basin is within the Angeles National Forest, a major recreation area of Southern California. The sub-basin's 50 or more miles of shoreline provides important bathing and fishing attractions making recreation one of the important industries. The commercial fishing industry of Southern California is centered at San Pedro where one-half or more of California's commercial fishing fleet and sardine processing plants are situated. Commercial fish landings in the sub-basin during 1947 were valued at over 25 million dollars and totaled around 475 million pounds, a comparatively low figure due to the scarcity of sardines in 1947.

Los Angeles County is one of the greatest industrial areas of the nation. In 1947, there were 9,472 establishments that employed over 350 thousand persons and had a total payroll of 1.1 billion dollars per year. During World War II the Los Angeles County Metropolitan Area became the aircraft manufacturing center of the world, and its industrialization was further accelerated by addition of metal working, synthetic rubber, and other basic industries.

One of the major natural resources of the sub-basin is crude petroleum which, in 1945, was pumped from 16 fields in the Los Angeles Basin. Crude oil production in 1947 was more than one-fourth of the State's production or about 92 million barrels valued at 164 million dollars. In that year, production of natural gas was nearly 95.7 billion cubic feet valued at 8.3 million dollars. Other mineral resources include natural gasoline, clay products, crushed crushed rock, sand and gravel and stone.

Summary of Water Pollution Data

There are 60 sewered communities with a combined population of 3,950,000 in the sub-basin. Nine of the 60, with a connected population of 59,000, discharge wastes with a population equivalent of 18,000 to percolation beds or other land disposal systems, and 51 communities with a connected population of 3,890,000 discharge wastes with a population equivalent of 2,305,000 to the Pacific Ocean. Industrial wastes with a population equivalent of 1,180,000 are discharged to public sewerage systems increasing to 5,070,000 the equivalent population served.

The 16 communities served by the Los Angeles City system and the 35 communities served by the Los Angeles County Sanitation Districts include substantially all of the 44 cities and 100 unincorporated communities located on the coastal plain of Los Angeles County. A total of 465 square miles or 51.4 percent of the 905 square miles in the coastal plain of Los

Angeles County is unincorporated, and only 15.5 percent of this unincorporated area is served by sanitary sewerage systems at present. Planned construction during the next two years will increase to 17.4 percent the unincorporated area served by sanitary sewers.

Based on the best available 1950 population figures, 3,950,000 persons out of a possible 4,096,500 or 96.4 percent of the sub-basin population is served by municipal sewerage systems.

It is estimated that there are over 10,000 industrial and commercial plants in operation in the sub-basin, but most of them are connected to public sewerage systems, and the population equivalent of their wastes is included in table A. There are 27 significant industries shown in table B which have separate waste discharges. Ten of the industries produce organic wastes, but the population equivalent of the wastes has not been determined. Seventeen of the industries produce inorganic wastes.

Thirty-six of the sewered communities, with a connected population of 1,770,000, are served by two primary sewage treatment plants. Thirty-five of the communities are included in the Los Angeles County Sanitation Districts served by the White Point ocean outfall. Twenty-four communities with a connected population of 2,180,000 are served by seven secondary treatment plants. Sixteen of the communities are included in the Los Angeles City system served by the Hyperion treatment plant and ocean outfall, and three are served by the tri-city system with the effluent used for irrigation.

Nine of 27 industries are food processing or similar type plants all of which have treatment facilities, one is a pulp and paper plant with treatment facilities, five are chemical or allied products plants only two of which have treatment facilities, five are petroleum products or similar plants all with treatment facilities, one is a metal fabricating plant with treatment, one is a rubber products plant with treatment, two are oil producing fields with waste prevention measures in effect and three are mining industries with waste treatment facilities.

Five of the municipal sewage treatment plants are satisfactory as to capacity and degree of treatment provided for present conditions and four are unsatisfactory. The four unsatisfactory plants are comparatively small and serve a connected population of only 12,000. The five satisfactory plants serve a connected population of 3,950,000, or 99.7 percent of the sewered population.

The treatment plants of the County Sanitation Districts and Los Angeles City have been designated as satisfactory for the purpose of this report although both plants were actually under construction as of July 1, 1950. The Hyperion plant is in partial operation, but construction of the new high rate activated sludge plant to serve a population of 3,000,000 has not yet been completed. Additions are also being made to the County Sanitation Districts primary treatment plant although major enlargements were made in 1947 and again in 1949. The two Los Angeles sewerage systems now serve a population of 3,890,000 or 98.5 percent of the sewered population of the sub-basin. The population of the Los Angeles metropolitan area is increasing so rapidly that the sewage flow to new collection and treatment facilities frequently has reached or exceeded the designed capacity by the time construction is completed. The phenomenal growth is expected to continue for at least another 20 years; so continued expansion of waste treatment facilities will be required.

Operation of seven of the nine municipal treatment plants is considered to be satisfactory. Operation of two of the plants is unsatisfactory, but the plants serve a connected population of only 750.

Seventeen of the 24 industrial waste treatment plants in the sub-basin are satisfactory as to design capacity and degree of treatment provided, five are unsatisfactory, and the adequacy of two has not been determined. Operation of 21 of the industrial waste treatment plants is considered to be satisfactory, and the adequacy of operation of three of the plants is undetermined.

Excellent progress has been made on pollution abatement in the postwar years. One treatment plant was rebuilt to serve a population of 1,500 in 1946; the Los Angeles County Sanitation Districts' plant was enlarged in 1947 to increase the designed population by 1,300,000 and again in 1949 to increase the designed population by 700,000; two plants were constructed in 1948 to serve a combined population of 40,400; and the new Los Angeles city plant is to be completed in 1950 for a designed population of 3,000,000.

Although four of the nine municipal treatment plants in the sub-basin are unsatisfactory for present conditions, the four plants serve a combined population of 12,000 or only 0.3 percent of the population of the sub-basin. Three of the four plants need additions or enlargements and one plant needs to be replaced by a new plant. Two of the four communities needing new waste treatment facilities have taken no formal action toward provision of the required facilities, and two of the communities have been ordered to abate existing nuisance conditions.

Information on the status and needs of waste treatment facilities for industries is not as complete as for municipalities, and no accurate estimate can be made of industrial waste treatment facility needs at present.

The major stream pollution problems in the sub-basin are on the Los Angeles River below Vernon. Although the average annual discharge to the ocean of the Los Angeles River is estimated to be between 60,000 and 70,000 acre-feet, the ability of the river to carry organic waste discharges without creating a nuisance is limited by lack of dilution water during the dry season. During the warmest weather, periods of "no flow" have occurred, and at times a series of foul stagnant pools have been formed. The ability of the river to carry inorganic wastes is also limited by the danger of pollutants percolating from the stream bed to subsurface waters in reaches where significant percolation occurs.

There are no direct discharges of wastes from sanitary sewer systems to the river, but some by-pass structures have been provided to discharge overloaded sanitary sewers to storm sewers during periods of peak flow. In many instances, industrial wastes have been discharged directly to the river or to storm drains in order to relieve the load on sanitary sewers. Conditions in the river became so bad that in May 1948 the Los Angeles River Pollution Committee was formed of representatives from interested public and private agencies. Through an extensive field survey and sampling program, all of the significant waste discharges to the river have been located and in many instances corrective measures have been taken.

Since 98.5 percent of the wastes from municipal sewerage systems are discharged to the ocean, pollution of coastal waters has been a serious problem in the sub-basin. In recent years as much as 14 miles of the extremely valuable beaches in the vicinity of Los Angeles have been quarantined. Pollution prevention measures adopted in recent years have improved conditions to such an extent that at present not more than seven miles of beaches are under quarantine, and when facilities now under construction are completed further improvement should be realized.

Pollution of subsurface waters in the sub-basin is an even greater problem than pollution of surface waters. A major portion of the water supply for the area is obtained from great natural underground basins located directly beneath the communities and industries of the coastal plain. Surface streams recover rapidly from the effects of pollution following adoption of control measures, but polluted ground waters recover slowly and may be permanently lost to beneficial use. The greatest dangers to the quality of ground waters are industrial discharges of inorganic wastes, and the Los Angeles County Board of Supervisors in 1945 wisely adopted a County Industrial Waste Ordinance to control industrial waste discharges and study the effect of such discharges on the quality of ground water.

Since passage of new State water pollution legislation in 1949, the Regional Water Pollution Control Board has been the primary agency responsible for coordination of water pollution control activities in the sub-basin. Several instances of damage to subsurface waters by industrial wastes have already been encountered and corrected, and work along this line is being intensified by all of the agencies concerned.

Table A_{11}. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	"To land" *** 9	58,750	18,075
	"To ocean" *** 51	3,890,000	2,305,000
Having population data available (Data on pollution load to watercourse incomplete or not available)	--	--	Not applicable
Total	60	3,948,750	—

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

***In the California Basins sewage collection and treatment systems discharge not only to watercourses where pollution of surface waters may be a problem but also "to land" where pollution of underground waters may occur and "to the ocean" where adequate dilution simplifies disposal. Accordingly, the sources of pollution are broken down into these two categories and listed as such in this table.

Table B_{11}. Sources of pollution, industrial*

Industries	Sources of pollution (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	--	--
Producing organic wastes	10	Undetermined
Producing inorganic wastes	17	Not applicable
Producing wastes of undetermined type	--	Undetermined
Total	27	--

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table C_{11}.
Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	36	2	1,770,250
Secondary	24	7	2,178,500
No treatment	0	--	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

Table D_{11}. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Manufacturing industries:				
Food and kindred products..................	9	9	--	--
Paper and allied products..................	1	1	--	--
Chemical and allied products..............	5	2	2	1
Products of petroleum or coal..............	5	5	--	--
Rubber products.........	1	1	--	--
Fabricated metal products (except ordnance, machinery, and transportation equipment)..	1	1	--	--
Nonmanufacturing industries:				
Oil production industry.	2	2	--	--
Other mining industries.	3	3	--	--

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table E_{11}. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	9	5	4	--	7	2	--
Industrial	24	17	5	2	21	--	3

Table F_{11}. Progress in pollution abatement

Year	Municipal		Industrial*	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	1	1,500	—	—
1947	1	1,300,000	—	—
1948	2	40,400	1	10,000
1949	1	700,000	—	—
1950	1	3,000,000	—	—

*There is such a small amount of data available on industries at the present time that it is impossible to complete this section of the table.

Table G_{11}. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	--	--	--
Enlargement or additions to existing plant	3	11,750	--
Replace existing plant	1	500	--
No project required	5	3,936,500	--
Undetermined	--	--	10

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

Table H_{11}. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	2	1
Abatement ordered	2	--
Plans under preparation	--	--
Final plans approved	--	--
Construction awaiting financing	--	--
Under construction	--	--
Status undetermined	--	9

SANTA ANA RIVER SUB-BASIN

Description and Economic Development

The Santa Ana River Sub-Basin is located along the southern coast of California between the San Gabriel River and Aliso Creek. The sub-basin is roughly rectangular in shape and approximately 60 miles long by 45 miles wide. Its total area is 2,730 square miles, representing 2.5 percent of the total area of the California Basins. Of this area 1,230 square miles are in Riverside County, 1,000 square miles are in San Bernardino County, and 500 square miles are in Orange County. The sub-basin boundary follows the watershed of the Santa Ana River except on the coastal plain where the divides are not well defined and political boundaries are being used by the Los Angeles and Santa Ana Regional Water Pollution Control Boards to simplify their work.

The sub-basin contains approximately 1,135 square miles of mountainous country, 1,235 square miles of valley, and 360 square miles of coastal plain. The mountainous area is highly eroded due to loss of vegetation cover by fire and overgrazing. The area includes approximately 21 miles of ocean shoreline and 560 miles of river and tributary streams.

The moist wind and fog from the ocean moderate the climate of the Sub-basin. Yearly mean temperatures throughout the valleys average 63°F. with the areas above 4,000 feet averaging 53° F. The range between mean high and mean low temperatures averages 30° F. The growing season ranges from 330 days near the coast to 151 days at higher elevations away from the coast. Along the coast the fog limits sunshine to less than 60 percent of the possible amount, but at distances ten miles and greater from the coast this figure increases to 75 percent. The total annual precipitation varies from 11.3 inches at Riverside (elevation 895 feet) to 16.9 inches at San Bernardino (elevation 1,172 feet), and 47.6 inches at Kelly's Kamp (elevation 8,300 feet).

The mountains that surround the valleys are steep and rocky. Although only 46 percent of the area is mountainous, probably two-thirds of the total precipitation falls in the mountains and considerably more than two-thirds of the total run-off originates there.

Perennial flow in the main stem of the Santa Ana River is confined to the reach between Riverside and Prado Dam where rising ground water is encountered. Few tributaries of the Santa Ana River in the valley areas have perennial flow, but flood waters discharged from canyon mouths onto gravel debris cones of the valleys percolate into the ground water basins and replenish the ground water supply.

The geological development of the region created impervious basins filled with porous material to a depth as great as 1,400 feet. Various faults crossing the valley have created barriers which retard the movement of subsurface waters and generally hold the water table near the surface. The total ground water storage capacity for a zone with average thickness of 100 feet extending 50 feet above and 50 feet below the normal water level is estimated to be 3,410,000 acre-feet. The combined capacity of the six main surface reservoirs that have been constructed in the sub-basin is only 228,000 acre-feet. Lake Elsinore is salt water and of no value except for recreation. Water conservation by spreading to increase percolation to the ground water has been found to be much more economical than surface storage.

The population of the sub-basin increased from 340,200 in 1940 to 567,400 in 1950, an increase of 67 percent in the ten year period. Approximately 70 percent of the population live in cities and towns, about 50 percent in the ten largest cities ranging in size from 10,000 to 62,000. The population density of the sub-basin was 208 per square mile in 1950.

Agriculture is the primary economic activity in the sub-basin. Citrus fruit is the most important crop, but deciduous fruits, nuts, grapes, field and truck crops, poultry, honey, livestock and dairy products are also important sources of income. Approximately 430,000 acres of land are under cultivation, 300,000 acres being irrigated.

Industrial activity is second in importance to agriculture but is expanding rapidly. The packing and processing of citrus fruits and other agriculture products is the largest industrial group, but the Fontana steel plant with an original investment of $110,000,000 is the largest single industry. Other important industrial activities are manufacturing portland cement, chemical and metallurgical products, canning and packing machinery, transportation equipment, electrical appliances, and repair of tank cars and transportation equipment.

Mineral production is largely restricted to non-metallic minerals including limestone, clay and gypsum in quantities nearly sufficient to supply the California demand for portland cement. Fine china, brick and tile are also manufactured from the high grade clay. Petroleum production is concentrated in the Orange County portion of the sub-basin and was valued at $66,800,000 in 1947.

Annual water consumption in the sub-basin averages 683,000 acre-feet of which 640,000 acre-feet is used for irrigation and 43,000 for domestic and industrial uses. From 20 to 25 percent of the water used is taken from reservoirs and surface streams and the rest is pumped from wells. There are nearly 200 water companies and districts in the sub-basin distributing water for irrigation and other uses, and in addition hundreds of farmers obtain their water supply from wells on their own property.

Most of the rights to divert normal flow from streams or to pump water from wells in or near the stream beds have been established by long usage, court decrees, or compromise agreements. Rights to pump water from other points in the underground basins were acquired, under California law, by purchase of overlying land, but the vested right is limited to that quantity of water that can be used beneficially on the overlying land.

The run-off from the mountains and hills discharged to the interior valleys and coastal plane averages 240,000 acre-feet annually, and an additional 30,000 acre-feet of run-off from the valley floor increases the total run-off to 270,000 acre-feet. Average annual waste to the ocean is only 29,000 acre-feet or one percent of the mean annual rainfall, and less than 5 percent of the mean annual demand for water in the sub-basin. This loss occurs during infrequent floods, and the excessive cost of constructing surface reservoirs to salvage part of the loss makes such construction unattractive.

The combined annual overdraft in the sub-basin was estimated to be 21,000 acre-feet from the Chino Basin and 14,000 acre-feet from the lower Santa Ana River Basin in 1946. The importation of 12,239 acre-feet of softened water in 1949 by the Metropolitan Water District of Southern California for domestic water supplies in the sub-basin and release of 11,000 acre-feet of raw water from the Colorado River for irrigation in the sub-basin during the 1949-50 season should reduce the overdraft to some extent.

The wells in the Sub-basin generally are from 200 to 800 feet deep with some reaching depths greater than 1,000 feet. The static water level is generally less than 300 feet depending upon the location of the well with respect to barriers between the underground basins. Mineral quality of well water in the area is excellent.

Recreational use of the available water resources is quite extensive. The 21 miles of coast include some of the most highly developed and widely used beaches in the United States. The area is easily accessible to the large populated centers of Los Angeles and on a typical holiday it is estimated that 250,000 persons use the Orange County beaches. Sport fishing along the coast is also important.

Inland recreational use is restricted to the mountain streams and to Big Bear, Elsinore, Hemet and a few smaller lakes. In general, the demand for recreational development far exceeds the existing facilities.

Summary of Water Pollution Data

The Santa Ana River Sub-Basin contains 45 sewered communities with a total connected population of 337,000 discharging domestic and industrial wastes to surface streams or watercourses, to land disposal systems, or to the Pacific Ocean. Known industrial waste discharges, with a population equivalent of 360,000, to the Orange County joint outfall sewer increase the population equivalent of the raw sewage to 697,000.

The treated wastes from seven communities, with a connected population of 118,000, are discharged to surface streams or watercourses. All of the wastes are given secondary treatment and in most cases post chlorination is provided. The population equivalent of the wastes from these seven communities as discharged to water courses is only 10,000. A total of 24 communities with a connected population of 86,000 dispose of treated wastes with a population equivalent of 26,000 to percolation beds or by other land disposal methods so that the effect of the wastes on the subsurface water is the only pollution problem that need be considered. The remaining 14 communities with a connected population of 133,000 discharge wastes with a population equivalent of 325,000 to the Pacific Ocean or tidal waters.

There are 34 known industrial sources of organic pollution and 16 sources of inorganic pollution discharging through separate outlets about which some information is available but not enough to permit determination of the population equivalent. In addition there are 50 known wineries and 19 known dairies about which little information is available.

Twelve of the 45 sewered communities with a population of 121,400 have provided primary treatment for their wastes at five treatment plants. Nine of these communities have joined together to build the Orange County joint outfall sewer with two primary treatment plants. The remaining 33 sewered communities with a connected population of 215,000 have constructed 31 treatment plants providing secondary treatment for their wastes. The cities of Ontario and Upland have combined to construct one plant and the San Bernardino Air Base helped finance extensions to the San Bernardino plant to provide adequate capacity to treat the camp sewage.

Thirteen of the 34 known industrial plants in the sub-basin with organic waste have provided treatment for their wastes. Only two of these industries are known to have no treatment facilities and the facilities at 19 of the industries have not been determined. All of the known industries with inorganic wastes have provided treatment facilities except two mining industries with no significant waste problems. All of the major oil producing fields in the sub-basin have provided lines for disposal of salt brines to the ocean, most of them through the Orange County joint outfall sewer, but there are individual operators still disposing of oil well brines where they may damage surface or ground waters.

Twenty-five of the domestic waste treatment plants in the sub-basin are considered to be adequate as to designed capacity and degree of treatment provided. Eight of the existing treatments works are considered to be inadequate for present conditions and the adequacy of three of the plants has not been determined. Operation of all of the plants is considered to be satisfactory.

There is not enough information available to permit judging the adequacy of the design and operation of the 27 known industrial waste treatment plants in the sub-basin.

Excellent progress has been made on pollution abatement in the sub-basin in recent years. One new complete treatment plant serving a population of 41,000 was completed in 1947, and four new complete treatment plants serving five communities with a combined population of 41,500 have been completed and placed in operation early in 1950. A comprehensive survey was completed in 1947 of the needs for sewage collection and treatment works in Orange County and a plan of financing the necessary works by the formation of sanitation districts covering most of the built up area of Orange County has been approved. The sale of the bond issue to provide necessary funds for construction is being temporarily held up because of certain relatively minor legal questions, but an administrative organization has been set up and work is progressing on the final construction plans. Under this plan, the present Orange County joint outfall sewer system will be taken over and extended and more adequate treatment and a longer ocean outfall will be provided.

One of the eight communities with unsatisfactory treatment facilities has final plans approved for construction of a new treatment plant, four of the communities have plans for new facilities under preparation, and the remaining three communities have taken no formal action toward provision of the necessary facilities.

The excellent progress that has been made on pollution abatement has been stimulated to a great extent by two Acts, known as Chapter 47 and Chapter 20, passed by the California State Legislature to help develop a postwar construction program for needed public works. Chapter 47, which became effective September 12, 1944, appropriated $10,000,000 for allocation to cities and counties for acquisition of rights-of-way and preparation of plans for public facilities, and Chapter 20 which became effective May 21, 1946, appropriated $90,000,000 to be allotted to cities and counties for construction of needed public works.

Damage to the main stem of the Santa Ana River from pollution is not significant as the river flows perennially only for a short stretch between Riverside and Prado Dam. The mountain streams tributary to the Santa Ana River are perennial streams, however, and are of utmost importance as public and irrigation water supplies. Increased use of the mountainous areas for recreational purposes makes it increasingly difficult to protect the streams from pollution. Pollution prevention of the coastal waters is also of the utmost importance as the beaches of the sub-basin are some of the most highly developed and used in the United States.

Pollution prevention measures now in effect or in the planning stage should provide protection to most of the surface waters in the sub-basin from municipal pollution, but a great deal of study will be required to evaluate the need for industrial waste treatment facilities. The effect of pollution on the subsurface waters of the sub-basin is of even greater importance than the effect on surface waters as substantially all of the domestic and industrial wastes from the Riverside and San Bernardino portion of the sub-basin eventually reach the subsurface water. There is no surface water normally exported from this area.

There are probably few areas in the United States where conservation and protection of the water resources is as widely practiced as in the Santa Ana River Sub-Basin. The first authoritative investigation of the quality of ground water in the sub-basin was started in 1904 by the United States Geological Survey and has been continued by State, county and local agencies. Thousands of samples of water have been examined to check the quality of surface and ground water, and there have been significant increases in the mineral content of some well waters in localized areas. There has also been some encroachment of marine and deep oil well salt brines along the coast.

Table A_{12}. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	"To watercourse" *** 7	118,450	9,690
	"To land" *** 24	85,510	26,360
	"To ocean" *** 14	132,750[1]	324,270
Having population data available (Data on pollution load to watercourse incomplete or not available)	--	--	Not applicable
Total	45	336,710	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

***In the California Basins sewage collection and treatment systems discharge not only to watercourses where pollution of surface waters may be a problem but also to land where pollution of underground waters may occur and to the ocean where adequate dilution simplifies disposal. Accordingly, the sources of pollution are broken down into these three categories and listed as such in this table.

[1] Industrial wastes with a population equivalent of 360,000 increase this total to 492,750.

Table B_{12}. Sources of pollution, industrial*

Industries	Sources of pollution (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	--	--
Producing organic wastes	34[1]	Undetermined
Producing inorganic wastes	16	Not applicable
Producing wastes of undetermined type	--	--
Total	50	--

[1] Does not include 50 known wineries and 19 known dairies in the Sub-basin for which little data are available.

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table C_{12}.
Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	12	5	121,350
Secondary	33	31	215,360
No treatment	0	--	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

Table D_{12}. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Manufacturing industries:				
Food and kindred products..................	34	13	2	19
Chemical and allied products..............	1	1	--	--
Primary metal industries	2	2	--	--
Fabricated metal products (except ordnance, machinery, and transportation equipment)..	3	3	--	--
Miscellaneous...........	3	3	--	--
Nonmanufacturing industries:				
Oil production industry.	5	5	--	--
Other mining industries.	2	--	2	--

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table E_{12}. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	36	25	8	3	36	--	--
Industrial	27	--	--	27	--	--	27

Table F_{12}. Progress in pollution abatement

Year	Municipal		Industrial*	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	--	--	--	--
1947	1	41,000	--	--
1948	--	--	--	--
1949	--	--	--	--
1950	4	41,500	--	--

*There is such a small amount of data available on industries at the present time that it is impossible to complete this section of the table.

Table G_{12}. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	--	--	--
Enlargement or additions to existing plant	3	6,200	--
Replace existing plant	5	141,550	--
No project required	25	165,740	--
Undetermined	3	23,220	50

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

Table H_{12}. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	3	--
Abatement ordered	--	--
Plans under preparation	4	--
Final plans approved	1	--
Construction awaiting financing	--	--
Under construction	--	--
Status undetermined	--	50

SAN DIEGO SUB-BASIN

Description and Economic Development

The San Diego Sub-Basin comprises a 3,950 square mile area that borders on the Pacific Ocean and Mexico and includes 36 percent of Orange County, a small part of Riverside County, and all of San Diego County with the exception of the desert area west of the coastal mountains. Approximately 800 square miles of the sub-basin area is level mesa or rolling hills and the rest is irregular mountainous terrain.

Extending about 50 miles inland, the sub-basin embraces over 150 miles of ocean frontage possessing great economic and recreational value, and seven principal coastal rivers--Santa Margarita, San Luis Rey, San Dieguito, San Diego, Sweetwater, Otay and Tia Juana. Stream slopes in the mountains vary greatly because of faults and abrupt changes in the rock formations along the channels. All of the streams have steep channel slopes at the higher elevations, some exceeding 500 feet per mile, while near the coast the slopes vary from 7 to 48 feet per mile. The maximum potential water yield of the sub-basin, including ground water, has been reported to be 160,000 acre-feet. The present dependable delivery of Colorado River water through the San Diego branch of the Colorado River aqueduct, which is constructed to half-ultimate capacity, is 67,000 acre-feet annually. In the San Diego County part of the sub-basin alone, upward to 50,000 acres of irrigated land are devoted largely to high value crops. Two or three times as many additional acres suitable for agricultural use remain undeveloped due to lack of water for irrigation.

The ground water basins, occupying only a small part of the sub-basin, are, in the upper reaches, narrow and shallow, while near the ocean usable storage capacity is limited by the threat of sea water intrusion. Water supply and water quality are subjects of paramount importance to the economic development of the area.

The vegetal cover is principally chaparral which grows densely over most of the mountains. Above an elevation of 4,000 feet, pine forests cover most of the western slopes. A State soil classification for the western part of San Diego County lists 52,000 acres of excellent alluvial land, 84,000 acres of good agricultural soil, and 95,000 acres of fair soil in the coastal region. In addition, there are 10,000 acres of miscellaneous soil in the highland basins.

The climate is semi-tropical and equable. The mean annual temperature is about 61°, 70-year period extremes being 25° and 110° according to the U. S. Weather Bureau. The mean seasonal precipitation at San Diego is about 10.3 inches of which around 80 percent falls from December to March, inclusive.

The sub-basin population is concentrated along the highly developed coastal area with an estimated 80 percent of the population concentrated in San Diego and the adjacent communities. The population increased from approximately 291,600 in 1940 to 538,000 in 1950, an increase of 85 percent in 10 years. The phenomenal growth was due in part to military activities and the expansion of war industries.

The chief industry in the sub-basin, exclusive of agriculture, is aircraft manufacture. In San Diego city the fish canning industry has an annual payroll of over $2,000,000, the tuna fleet including over 100 boats. A salt company produces over 40,000 tons of salt annually by solar evaporation.

Mineral production in the sub-basin during 1947 included sand and gravel, stone, clay products and a wide variety of other minerals the total value being around two million dollars.

In 1946, there were seven active sawmills in the sub-basin, the lumber production totalling nearly two million board feet. Principal trees are ponderosa pine, white fir, and California red fir.

The 1949 total agricultural crop value for San Diego County was about $34,000,000, the principal crops in order of value being tomatoes, celery, lemons, avocados, oranges and green beans. The livestock value for 1949 was $27,000,000; the number of acres in farms, 911,000; the total number of farms, 5,430, their value being $83,000,000; and the average size of the farms, 167.7 acres.

Irrigation of most crops is necessary in the agricultural areas of the sub-basin because of the low seasonal rainfall and the long dry summers. Most of the irrigation water for the alluvial valleys is pumped from privately owned wells, the average annual delivery of water being 1.3 acre-feet per acre and the average cost $25 per acre-foot. For the hillside lands including most of the citrus and avocado groves, irrigation water is secured from large scale irrigation developments.

Apart from rapidly increasing domestic and industrial use, the main use for water in the sub-basin is agricultural. On the terraces of the coastal belt over 20,000 acres are used for dryfarmed field crops, principally grains. Citrus fruits and avocados are grown by irrigation on about 25,000 acres on the hills and mesa around Fallbrook, Vista, Escondido, Rancho Santa Fe, Lemon Grove, Chula Vista, and adjoining the lower Sweetwater River Valley. The most serious problem with respect of agricultural use arises in the San Dieguito River because of the high salt content of the ground water.

The commercial use of the coastal waters of this sub-basin is principally for the offshore fin fishery. Most of the landings represent catches in waters south of the international boundary. In 1947, the total commercial fin fish catch in the California waters off the sub-basin shoreline was only 10,400,374 pounds as compared with 149,366,074 pounds landed from waters south of the international boundary. Small fisheries for the spring lobster and for abalones are operated in the coastal area.

Of approximately 448,000 sport anglers for marine species in California during 1947, around 36,139 fished off the shores of this sub-basin. The total number of fish caught was 108,121 and their weight was 503,182 pounds. This is equivalent to 2.99 fish per man-day or 13.92 pounds per man-day. The main species caught are kelp bass, sand bass, barracuda, yellowtail and rockfish.

Inshore fisheries are of limited extent on account of seasonal changes in stream flow. Fresh-water sport fishing is carried on more particularly in the mountains. In point of numbers caught, sunfish and crappies are the two most important species in lakes and rivers of the southern counties of California. During 1948, approximately 42,000 fishermen caught nearly 2,000,000 sunfish; 57,000 fishermen caught 1,500,000 crappies; about 33,000 fishermen caught approximately one-half million black bass. The catch of trout was relatively low, numbering 84,000 fish, the number of trout fishermen being 5,500.

Recreational use of water is highly important in the Cleveland National Forest situated in the higher altitudes on the eastern side of the sub-basin. According to the U. S. Forest Service data, a figure of 462,839 man-days of recreational use was reached in 1948. Recreational use of the shoreline, including bathing and surf fishing, is general along the entire coast of the sub-basin.

Summary of Water Pollution Data

There are 42 communities in the sub-basin including municipalities and other legal bodies, institutions, resorts, and camps discharging domestic and industrial wastes from sewerage systems. The actual connected population of the 42 communities is 534,000 plus 77,000 population equivalent of industrial wastes discharged to the municipal sewers. There are 12 Army Department installations included in the 42 communities, most of which were staffed with skeleton forces only, at the time of this survey in May 1950; so the population indicated could increase rapidly in case of an emergency. The city of Tijuana, Mexico, sewered population 26,500, is included with San Ysidro, California, as one community since the sewage from the two communities is discharged through a joint outfall sewer to the San Diego Sub-Basin.

The population equivalent of the wastes is reduced by treatment to 385,000 before being discharged. Of this total, only 9,000 goes to water courses where there is a possibility of polluting surface waters; 1,000 goes to percolation beds or other land disposal systems where there is a possibility of damaging the subsurface water; and 375,000 goes to San Diego Bay or other tidal salt waters where the large dilution factor makes the BOD relatively less important.

There are 22 known industries with separate waste discharges in the sub-basin. All of the wastes produced are organic in nature, and the population equivalent BOD from 10 of the plants is estimated to be 80,000. Not enough information is available to estimate the population equivalent of the other 12 plants. The three citrus fruit packing plants at Escondido use boron, soda ash, and soap which may damage surface or ground water used for irrigation.

There are 43 treatment plants in the sub-basin treating wastes from the 40 communities. A total of 22 of these plants serving a population of 473,000 provide primary treatment, while 21 plants serving a population of 42,000 provide secondary treatment. Two communities with a population of 18,600 discharge raw wastes to San Diego Bay without treatment.

Six of the 22 industries that are known to have waste disposal problems have treatment facilities of some type. Twelve of the industries have no treatment facilities and the treatment facilities provided by the remaining four industries are unknown.

A total of 30 of the 43 municipal waste treatment plants are considered to be satisfactory as to design capacity and degree of treatment provided. The remaining 13 treatment plants are considered to be unsatisfactory either as to capacity or degree of treatment. Thirty-one of the treatment plants are considered to be satisfactorily operated, nine unsatisfactorily operated, and operation of three of the plants is undetermined. The adequacy of capacity of 3 of the six industrial waste treatment plants is considered to be unsatisfactory while the adequacy of capacity of the other 3 and the operation of all six is undetermined.

Good progress has been made on pollution abatement during the postwar years. One municipal waste treatment plant with a design capacity of 8,000 was completed in 1948, and four others serving a population of 17,200 were completed and placed in operation during the first six months in 1950.

New waste treatment facilities are required for two communities with combined populationof 18,600 which now have no treatment facilities and for eight communities, with a population of 32,600, to replace existing facilities. Five projects are also required to enlarge or extend existing facilities to serve a population of 16,900. No projects are required at 30 treatment plants serving a combined population of 465,400. Six industries are known to need new treatment facilities and three more are known to need enlargements or additions to existing treatment facilities. The needs of thirteen industries are unknown.

Three of the 15 communities requiring treatment facilities have taken no formal action toward construction, six have plans under preparation; four have final plans prepared and approved, one has been ordered to abate pollution, and the status of one is undetermined. The nine industries known to require treatment facilities have plans under preparation to connect to existing community waste treatment facilities. The status of the remaining 13 is unknown.

Surface water quality in the sub-basin is generally satisfactory for indicated uses except at a few beach areas adjacent to sewer outlets and in a few short reaches of streams receiving inadequately treated sewage. Fecal material is now deposited along the Coronado Beach on San Diego Bay from raw sewage discharged to the Bay. Present plans to connect the Coronado sewer to the San Diego system should improve the condition of the beach. Operation of the new sewage treatment plant at Oceanside should also improve the formerly unsatisfactory beach condition near the Oceanside sewer outlet. Beach conditions near sewer outlets at San Clemente, Carlsbad, S. D., Capistrano Beach S. D., Doheny Beach, Dana Point, and Tijuana-San Ysidro are also unsatisfactory at times.

The Julian, S. D. effluent overflows into Coleman Creek and San Diego River 19 miles above the El Capitan reservoir which is a part of the San Diego water supply. A nuisance condition exists in the small creek below the El Cajon sewer outlet, but irrigation of field crops is the principal water use. Salt Slough at Del Mar also becomes septic during the racing season due to the greatly increased load.

Table A_{13}. Sources of pollution municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	"To watercourse" *** 17	31,910	8,950
	"To land" *** 6	2,965	985
	"To ocean" *** 19	498,620[1]	372,520
Having population data available (Data on pollution load to watercourse incomplete or not available)	--	--	Not applicable
Total	42	533,495	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

***In the California Basins sewage collection and treatment systems discharge not only to watercourses where pollution of surface waters may be a problem but also to land where pollution of underground waters may occur and to the ocean where adequate dilution simplifies disposal. Accordingly, the sources of pollution are broken down into these three categories and listed as such in this table.

[1] Industrial wastes with a population equivalent of 76,885 discharged to municipal sewer systems increase this total to 575,505.

Note: Includes 12 War Department installations most of which were staffed with skeleton forces only at the time of this survey in May 1950. Also includes population of 26,500 in Tijuana, Mexico, and 60 in San Ysidro, Calif., served by the Tijuana-San Ysidro Joint Outfall Sewer.

Table B$_{13}$. Sources of pollution, industrial*

Industries	Sources of pollution (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	10	80,700
Producing organic wastes	12	Undetermined
Producing inorganic wastes	--	Not applicable
Producing wastes of undetermined type	--	Undetermined
Total	22	---

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table C$_{13}$.
Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	21	22	472,850
Secondary	19	21	42,045
No treatment	2	--	18,600

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse.

Table D$_{13}$. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Manufacturing industries: Food and kindred products...............	22	6	12	4

*Industries having separate outlets and discharging wastes directly to watercourse or land.

Table E$_{13}$. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	43	30	13	--	31	9	3
Industrial	6	--	3	3	--	--	6

Table F_{13}. Progress in pollution abatement

Year	Municipal		Industrial*	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	—	—	—	—
1947	—	—	—	—
1948	1	8,000	—	—
1949	—	—	—	—
1950	4	17,200	—	—

*There is such a small amount of data available on industries at the present time that it is impossible to complete this section of the table.

Table G_{13}. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	2	18,600	6
Enlargement or additions to existing plant	5	16,940	3
Replace existing plant	8	32,550	—
No project required	30	465,405	—
Undetermined	—	—	13

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

Table H_{13}. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	3	—
Abatement ordered	1	—
Plans under preparation	6	9
Final plans approved	4	—
Construction awaiting financing	—	—
Under construction	—	—
Status undetermined	1	13

*U. S. GOVERNMENT PRINTING OFFICE : 1951 O - [illegible]